

Annual Report of the
Rubber Research Institute
of Malaya 1952



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RUBBER RESEARCH INSTITUTE OF MALAYA
KUALA LUMPUR

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PREFACE

THIS *Report* resumes the custom of annual publication of the reports of the several divisions of the R.R.I. together with those of the Director and of the Board.

To some extent the *Reports* of the R.R.I. have in the past become a medium for recording experimental results as such. This will henceforth be avoided by recourse to the *Journal*. Perhaps the most important function of these *Reports* is to give an account of progress to the rubber producers of Malaya, who foot the bill. This aim will be kept in view, in an endeavour to present *Reports* which are succinct and readable, with comment on the practical significance of work progressed or completed during the year under review.

An important trend is also reflected in that ADVISORY work is described more fully, and separately from RESEARCH. Much of the kind of work previously described under the heading INVESTIGATIONS is now to be found in the parts entitled ADVISORY.

This *Report* for 1952 covers the fourth year of the Malayan Rubber Fund Five Years Plan 1949 - 53. The numbering of sections under the headings RESEARCH is that of the research programme approved under that plan.

INTRODUCTION BY DIRECTOR

THIS WAS THE FOURTH YEAR OF OPERATION of the five years programme of expansion of the organisation and work of the R.R.I., prepared jointly with the British Rubber Producers' Research Association and the British Rubber Development Board, financed by the Malayan Rubber Fund from the proceeds of the cess of one quarter of a cent a pound on exports and supported by a guarantee by the Federal Government as recorded in Legislative Council Paper No. 40 of 1949. Financial details follow the report of the Board, on page 108. Service was extended to other rubber producing countries, North Borneo, Sarawak, and Nigeria, whose governments contribute to the Malayan Rubber Fund.

During the year recruitment of senior research and advisory staff and work on major capital extensions provided in the approved programme made good progress. At the end of the year there remained two vacancies on the senior staff. The new laboratories for expansion of research work on the Experiment Station, equipment of a new factory and building of staff houses at Sungei Buloh and in Kuala Lumpur neared completion.

Activities and expenditure were divided almost equally between research and advisory work. For estates and larger holdings advisory services were provided direct from the appropriate divisions, and for smallholders principally through the Smallholders' Advisory Service. Separate reports follow under the respective heads, but the work is surveyed in brief immediately below. It can be broadly divided into two fields, work on the tree and work on the product.

Work on the tree includes breeding and selection, study of tapping systems, soil investigations, cultivation and manuring and the control of diseases and pests. This field is covered by the Botanical, Soils and Pathological Divisions. Work on the product begins from the moment of tapping and continues through all stages of collection, treatment of latex and processing of rubber to the preparation of the finished products for export. This is the province of the Chemical Division. After brief survey of the work of the divisions, some fuller account immediately follows, of the Statistics Section, of the Experiment Station, and finally of information.

Staff of the institute took part in the Rubber Conference at Bogor, Indonesia, and in the XIII International Horticultural Congress at London.

SOILS DIVISION

Further progress was made in the survey and classification of the soils on which rubber is grown, and new investigations were started arising from discussions and field excursions early in the year

in Kedah and Selangor with Dr H. Greene, a member of the London Advisory Committee for Rubber Research (Ceylon and Malaya) and adviser to the Colonial Office on tropical soils.

Manuring of young rubber in experimental areas of twelve to fourteen years of age showed, after two or three applications of fertilisers, significant increases in girth in response to phosphorus and nitrogen. Increases in yield did not, however, appear, save in one or two instances. In other experiments, heavy dressings of fertilisers up to three times normal amounts failed to prevent repeated and abnormal leaf fall from clone BD 5. Young immature trees (particularly of clone PB 86) showing yellowish foliage suspected to be due to magnesium deficiency did not respond to magnesium fertilisers.

In work on the control of weeds and cover plants using weed killers, lalang (*Imperata cylindrica*) was successfully killed by two or three sprayings with an oil/water formulation containing STCA (sodium trichloracetate) and sodium pentachlorophenate. Single sprayings with CMU (N-p-chlorophenyl N',N'-dimethyl-urea) have also been effective. Both treatments are too costly for general application, but may be used effectively in areas where the use of sodium arsenite cannot be permitted. Observations were also made on the responses to a range of weedkillers of other types of covers and weeds occurring on rubber estates and tests were in progress using pre-emergence spraying to reduce weed control in rubber seedling nurseries.

Observations on mechanical cultivation on estates have shown that light powered wheeled tractors can be successfully used with attachments (some of them home made) for weed control in young and old rubber. A single tyne attachment will rake out creepers along the edges of cleared rows in young replantings; heavy chains or short lengths of rails are effective in breaking down heavy lalang prior to ploughing; a length of girder iron, convex in shape, and attached to the front of the tractor, will break down bush covers in mature rubber as an alternative to hand slashing.

In an experiment in twenty year old rubber, a combination of fertiliser treatments with ploughing and harrowing failed to affect the yield of the trees.

Laboratory investigations into the nature and distribution of forms of phosphate in soils, before and after treatment with phosphate fertilisers, emphasised the speed and completeness of conversion of the added phosphate into inert and unavailable forms. The work also suggests the importance of organic forms of soil phosphorus and of soil organic matter in relation to phosphate nutrition.

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Carried out over twelve months, field studies of soil nitrogen gave no indication of abnormal fluctuations or accumulations of ammonia or nitrate nitrogen. Rubber seedlings grown in nutrient solutions showed no differences in rubber hydrocarbon content except as a result of improved plant growth.

Laboratory tests on residual arsenic toxicity in soils indicated that even on sandy soils fifty rounds of spraying with arsenite, at a rate of 12 pounds per acre per spraying, would be needed before toxic conditions develop; on average inland soils nearly four times this amount would be required.

Considerable work has been done on the estimation of available plant nutrients in Malayan soils, and on the adaptation of new methods of chemical analysis of soils and plant materials.

In cooperation with the Plant Physiologist attached from the Botanical Division, an extensive programme of nutrient studies on the rubber tree commenced; preliminary work involved studies of diurnal variation in the nutrient content of rubber leaves, interclonal differences in leaf composition, and in composition of the bark. The value of this work in the diagnosis of nutrient deficiencies under field conditions was being studied.

BOTANICAL DIVISION

Breeding and selection continued to be the main item of the botanical programme. In course of this work some 8,000 'pedigree' seedlings of 214 families or crosses had been bred and tested. During the year examination of all new material in this collection, established on the Experiment Station before the Japanese occupation (and identified from detailed records and plans preserved by members of the local staff of the R.R.I.) was completed. Out of over 4,000 clones established 184 were selected for further trial and 1,504 were immature.

Of the earlier selections, clones of the RRIM '500' series in large scale trials totalling 547 acres had been tapped and recorded for five years or more, in comparison with some of the older proved clones and clonal seedlings derived from them. Results showed that the clonal seedlings and the older proved clones gave yields of about the same order. A number of the '500' series clones, particularly RRIM 501 and 513, gave considerably higher yields.

A second group of new clones — the RRIM '600' series — was established during the year in 36 trials totalling 516 acres on estates in all parts of Malaya. Budwood of a selection of these clones will be available for further distribution to estates for small scale trial in 1953.

In the course of an exchange of clones between Malaya and Brazil budwood of twentyfive RRIM clones were despatched to the Instituto Agronomico do Norte, Belem, Brazil and the same number of Brazilian clones showing a high degree of resistance to South American leaf blight were despatched from Brazil and established at a U.S. Department of Agriculture Quarantine Station in Florida for multiplication and observation before onward despatch, through Kew, to Malaya. This new material will be used in future breeding work.

Tapping experiments on estates and the Experiment Station continued in recording. A slaughter tapping experiment on seedling trees with and without the use of yield stimulants was yielding interesting results. Experiments on yield stimulation with proprietary stimulants, synthetic hormones in an oil carrier and injections of copper sulphate into the trees progressed.

PATHOLOGICAL DIVISION

The problem of root disease control in replanting old rubber was being investigated in a large experiment on coastal soil, and stump poisoning procedures alone were under test on an inland site. Significant results should be accumulated after several years. A third experiment laid down in a 1948 replanting had to be abandoned. Another approach to the problem was simultaneously being made through an investigation of those soil fungi which are antagonistic to root diseases.

Work on mouldy rot followed two lines: an investigation of promising synthetic detergents and a study of the established tar acid fungicides in collaboration with workers in the United Kingdom.

One of our functions is to maintain a watch on disease incidence. Secondary leaf fall was not severe, the season being unsuited to development of mildew. Much of the immature leaf fall which occurred, particularly during the subsidiary season August-September, was brought about by *Gloeosporium* and mites. Pink disease was reported as particularly serious on clone RRIM 501, and the need for treatment in damp areas where it thrives was apparent.

Research which was in train for several years to find a method of combatting South American leaf blight culminated in successful aerial spraying trials. It was shown that the defoliation of mature rubber can be induced by application of as little as one gallon per acre of a 5% solution of n-butyl 2,4,5-T in Diesoline. There is also the possibility of some such method being employed in destroying old rubber for replanting.

INTRODUCTION BY DIRECTOR

Locally severe pests included cockchafers, slugs and rats, while a characteristic bark injury of young plants was attributed to woodpeckers.

The demand for cultures of root nodule bacteria to inoculate legume cover crop seed was double that in 1951.

CHEMICAL DIVISION

Research on the fundamental chemistry of latex made good progress. Particular attention was given to the isolation and identification of non-rubber substances present in fresh latex. Such substances are known to have a marked influence on the properties of concentrated latex and dry rubber prepared from natural latex. Non-rubber constituents containing phosphorus and nitrogen were found to be of special importance.

Other fundamental researches on the rubber hydrocarbon showed that the size of the rubber particle or molecule is by no means constant, and that the technological properties of dry rubber prepared from latex containing a large proportion of large molecules may be superior to those of rubber prepared from 'small molecule' latex. It was also found that changes in the size of the rubber molecule might occur during processing with varying effects—some beneficial but usually otherwise—on the quality of the final product. The object of all work in this section is to discover the underlying causes of variation in the technical qualities of natural rubber and having found them to devise new methods of processing that will ensure improvement in the value of the final product. Part of the work in this field has been undertaken in close cooperation with the B.R.P.R.A.

Work continued on the study of the preparation and preservation of concentrated latex. New information on factors affecting the stability of concentrated latex was obtained and usefully applied. A new test based on determination of volatile acids in the product proved useful in the evaluation of samples of latex concentrates and in locating causes of trouble in manufacture. The search continued for a satisfactory preservative for concentrated latex alternative to ammonia, and many new preservatives and bactericides have been investigated. In cooperation with the Botanical Division and as a part of the procedure for testing new clones, detailed studies of the latices of new selections were carried out and will be continued before new clones are released for commercial planting. Tests on the latex from trees that had been treated with various yield stimulants, including copper salts, failed to reveal any abnormalities in properties or quality.

Technological work on dry rubber was concerned with two main projects, study of the variation in technological properties of dry rubber in the various forms produced for export, and the development of 'special' rubbers that may be of particular value to users. Regarding the latter project, work on the preparation of new products, by the incorporation of carbon black and lignin at the 'wet' or latex stage followed by coagulation and preparation of dry masterbatch rubbers, gave promising results. The study of variability in properties, which forms the basis of the development of the scheme for technical classification of rubber, also entailed new work on the improvement of testing methods and in the modification of methods of preparation of sheet and crepe rubber on estates. It was found that the addition before coagulation of traces of certain chemicals, which have no harmful effect on the properties of the rubber, may improve uniformity of the rubber. Further investigations on the influence of bulking of latex, standardisation of preparation and processing have been carried out at the Experiment Station.

Research on methods of preparation and processing, undertaken at the new factory at Sungei Buloh, included work on new plant for the preparation of sheet and crepe. Development of a line ahead battery for the preparation of crepe, and on a new type of sheeting battery, made some progress. Work on improvement in methods of packing and baling also received attention, especially in regard to bale coating preparations which had been the source of numerous complaints from consumers.

During the first half of the year a good deal of work was done on the preparation of rubber powder by the Mealorub process—50 tons of powder were produced for use in road surfacing trials. Towards the end of the year, in cooperation with Rubber Technical Developments Ltd, a joint organisation of the B.R.P. R.A. and the B.R.D.B., a pilot plant for the manufacture of cyclised rubber was installed on the Experiment Station and about 1,000 lb of the new product prepared for evaluation by manufacturers of shoe soling material in the United Kingdom.

Technical Classification of Rubber — Development of the scheme for technical classification of Malayan rubber made notable progress. The rate of production of T.C. rubber on estates increased steadily through the year to a rate of 22,000 tons per year in December. Extension of the scheme to the classification to RSS 3 passing through packing houses proved possible, by means of a simple blending procedure before packing. Four packing houses cooperated in this project, one of them since producing technically classified RSS 3 at a rate of 1,500 tons per year. At

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the request of the Rubber Producers' Council, the Board agreed to increase the facilities for testing and classification of rubber at the institute and to extend the scheme as quickly as possible to other grades of Malayan produced rubber. Coordination of all work on technical classification of natural rubber is provided by the International Rubber Research Board.

SMALLHOLDERS' ADVISORY SERVICE

At the end of the year the field staff consisted of three Superintendent Rubber Instructors, 37 Rubber Instructors and 55 Rubber Demonstrators. A third senior officer was appointed in November.

The major effort of Rubber Instructors continued to be directed to the encouragement of replanting on obsolete smallholdings; during the year over 4,000 acres were replanted. The rate of new planting increased and over 6,500 acres were completed during the year. Of the new planting and replanting undertaken in 1952 nearly 70% was done with clonal seedlings; of previous plantings with ordinary seedlings Rubber Instructors report that nearly 2,000 acres were budgrafted in the field.

For the provision of approved planting material (supported by a C.D. & W. grant under Scheme D.1176) increased efforts were made to obtain reliable supplies of clonal seeds. A memorandum explaining the purpose of the scheme and conditions for collection and supply was circulated through The United Planting Association of Malaya. The amount of seed collected from estates which had not been regular suppliers in earlier years was however negligible, and with a poorer seeding season the total collection during the year amounted to less than $4\frac{3}{4}$ million seed. Supplies were distributed mainly to Agricultural Department and smallholders' cooperative nurseries throughout the country. A relatively small proportion went to the central supply nursery on the R.R.I. Experiment Station. These seeds will provide the clonal seedling stumps for distribution to smallholders in 1953.

The sale of latex by smallholders, either to small central sheet making factories or to large organisations manufacturing latex concentrates, continued to be a popular method of marketing and nearly 4,300 tons of smallholders' rubber were sold in the form of latex during the year. The quantity thus sold varied considerably from month to month but the trend was generally upwards, reflecting the increased number of centres collecting or processing smallholders' latex.

From funds provided in part by the C.D. & W. grant, training courses for young men, preferably the sons of smallholders,

were arranged and 69 youths from villages throughout the Federation attended 4 months courses on rubber growing and production at the Experiment Station, and were awarded graded certificates after examination.

An illustrated manual on budgrafting in Malay, Chinese, Tamil and English editions and a leaflet in Jawi describing the preparation of clonal seedling stumps were issued. Short plays or talks dealing with smallholders' rubber growing and production were written by Rubber Instructors and broadcast in the community listening programme of Radio Malaya each week from April. A series of six instructional films on rubber growing and processing made by the Malayan Film Unit for the Rubber Research Institute have been shown to smallholders throughout the country by the mobile units of the Department of Information. Brochures emphasising the most important points in the films were distributed by Rubber Instructors, who attended each showing of the films to give short talks and answer questions.

STATISTICS SECTION

During the year Mr Fong Chu Chai, Assistant Statistician, left for the United Kingdom on study leave to undertake a three year course in statistics. Mr D.K.D. Ray joined the staff in May as Assistant Statistician making the strength of the Section one Statistician (Mr D.R. Westgarth), one graduate assistant, and two computers.

The Section continued to be mainly occupied in providing assistance on the design and interpretation of experiments carried out by the four divisions, and about 15 per cent of its time was given to external work of this kind. Altogether about 150 statistical reports on experiments were made during the year, and the following outline of some of this work illustrates the varied types of investigation on which the section was employed.

The statistical work on behalf of the Botanical Division centred mainly on the analysis of records of clonal seedling trials and trials of the RRIM '500' series clones. Plans were devised for several new trials of the RRIM '600' series clones. Where possible, layouts of simple randomised block form were adopted, although on a number of sites with uneven topography and contour planting, balanced incomplete block designs were used. A new departure was the design of a trial of 343 clones in a cubic lattice pattern.

Statistical studies were made of several tests concerned with factors affecting seed germination success, and an assessment was made of the efficiency of a staining technique for estimating probable germination success.

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A detailed examination was made of preliminary test yields from families of the 1950 hand pollinated seedlings at the Experiment Station and appropriate sampling intensities for this type of yield recording were determined. Further experience was gained of the variability encountered in trials to test yield stimulation and bark renewal treatments, and the optimum amount of sampling and recording was established. This type of experiment can be economically accommodated in the boundary rows of plots of other trials.

Although most of the botanical data subjected to analysis arose from formal field trials, some study was made of commercial yield data from estates. The use of such information as a basis for accurate comparisons of clone performance is handicapped because of many extraneous factors. Data on changes in estate yields coinciding with alterations in tapping systems proved slightly more tractable.

The problems associated with developments in the technical classification of rubber provided considerable scope for statistical methods, and the section assisted the Chemical Division in their investigations into the technological variability of packing house rubber and the reduction of bale differences by modifying existing packing procedures. Progress was made in overcoming the difficulty of classifying rubbers having borderline technological properties.

The appropriate sampling procedure for estimating counts of fungi in soils was investigated in collaboration with the Pathological Division. The aerial spraying trials of the Pathological Division called for estimates of drop size from measures of stain diameter; a relationship was derived from experimental observations and was found to agree closely with theoretical expectation.

Most of the statistical work for the Soils Division dealt with the analysis of results from the extensive series of manuring experiments located on estates throughout the country. Analyses of yields and girth increments were carried out for the individual trials, with a view to consolidating the evidence from similar experiments over a period of years.

Statistical methods were applied in an assessment by the Soils Division of the various methods of estimating available potash and phosphate in soils, and a comparison was made of the ability of certain methods to discriminate between soils which were known to respond or not respond to phosphate manuring. Other laboratory work using statistical techniques included a study of the effect of fertilisers on the chemical composition of the stem

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wood of hevea seedlings and an appraisal of different methods of estimating rubber content of leaves.

R. R. I. EXPERIMENT STATION SUNGEI BULOH

The Manager, Mr R.F. Harley, was on duty throughout the year. Mr A.E. Browne, the Assistant Manager, was on leave from February to September, and Mr G.A.D. Hooper joined as Assistant in February. Six members of the junior staff were on long leave at various times.

The labour force increased slightly to 405 on checkroll (249 dependents) and 45 on contract (tappers).

The new factory and power house were in operation throughout the year and all machinery worked satisfactorily except the scrap creping battery over which there was some delay in assembling to satisfaction. A new Cochran oil fired boiler was installed for steam production.

Seventyfour trainees were instructed in planting practice in two courses of four months each.

Survey of new areas developed since 1946 was completed and full recorded acreages are

	<i>Acres</i>
Mature areas — tapped	1,131.25
Mature areas — rested	13.50
Immature areas and nurseries	559.25
New clearing 1952	57.75
Smallholders' nurseries and seed garden	191.75
Building sites, roads and reserves	202.50
<i>Total</i>	<i>2,156.00</i>

Older mature areas were under routine maintenance except for experimental areas in which special manuring and cultivation treatments were being applied. Routine manuring was done on 140 acres of mature rubber, and 151 acres of immature rubber on land brought into cultivation from lalang since the war.

Detailed inspection for root diseases and treatment of cases was carried out over 353 acres of mature rubber and 497 acres of immature postwar plantings. Part of this work and other detailed work of a similar nature, was undertaken for experimental purposes.

The total crop harvested was 1,069,020 lb which averaged at 945 lb per acre. Details of grades were:

	<i>lb</i>
RSS 1	601,082
RSS 2	30,500

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	<i>lb</i>	
RSS 3	2,000	
Clippings	7,500	
Scrap and lump crepe	86,557	
Air dried sheet	280	
Rubber powder	109,133	
Cyclised rubber	1,789	
Unmanufactured:		
Sold as latex 43,490 lb		}
Scrap 102,865 lb		
Cup lump		
(samples) 83,824 lb		
		230,179

The average cost of production of all grades excluding rubber powder and cyclised rubber was 39 cents per lb.

A new area of about 58 acres was cleared and planted from lalang and secondary growth, for budding in 1953 with new selection material. Except for a plantable reserve of about 50 acres this completes the planting of some 600 acres of experimental areas since 1947.

The special reserve area for production of approved planting material for smallholders was supervised by the Experiment Station staff. The original nursery area of about 192 acres was interplanted on a hedge system with rows 60 feet apart; budding of the hedges with selected parent clones was completed. In the main multiplication nurseries budding was completed over 65 acres with approved clones; over 500,000 yards of budwood were available for distribution at the end of the year. From the clonal seedling nurseries planted in 1951, some 619,000 stumps were pulled and despatched to smallholders.

Details of experimental work will be found in the full reports of the divisions which follow.

I N F O R M A T I O N

Provision for information, in the limited sense including publication and the library, was continued under the heading of administrative charges. The Secretary, Mr H.S. Blacklin, undertook this responsibility until July when Mr D.R. Rexworthy was newly appointed for the task. Mr K.L. Patrick was on duty throughout the year as library assistant. In November Mrs. J. Tambling was appointed part-time for training as an editorial assistant, to enable Mr Rexworthy to study the information function generally, and advisory organisation especially.

A new procedure to streamline the internal circulation of periodicals – there are upwards of 400 titles – was devised by the

end of the year, also an improved translation service. Publishing activity increased during the year; notably, *Planters' Bulletin* recommenced in a new series. This publication reaches the planting community promptly on the first day of each alternate month. It is the medium of the institute's service to estates, and with its establishment the numbered series of Circulars has lapsed. The *Journal of the Rubber Research Institute of Malaya* continued with Volume 14.

A general expansion of information services is commencing, with the accent coming upon external information, rather than internal. This trend is basic, for the provision of information, in its broader sense and including advisory activities, is one of the two main functions of the institute as laid down in its mandate. As the new research programme develops and the fund of knowledge grows, so the need for application of that knowledge is rapidly increasing.

C.E.T. MANN
Director

SOILS DIVISION

A NUMBER OF CHANGES in the senior staff occurred. Mr G.M.F. Grundy was appointed Soils Chemist at the end of 1951 and went on special study courses at the Imperial College of Tropical Agriculture, Trinidad, B.W.I., and at Rothamsted Experimental Station, England. He is expected in Malaya early in January 1953. In April 1952, while on leave in the United Kingdom, Mr W.H. Williams, Soils Chemist, resigned his appointment. Dr E.W. Bolle-Jones (Plant Physiologist), who joined the Botanical Division in August 1952, was attached to the Soils Division shortly after his arrival, where he was able to use existing facilities to commence immediately his programme of work.

During the year, the Head of the Division was appointed Acting Deputy Director and assumed these additional duties from May until September. He was also appointed to act for the Director during the latter's absence in New Guinea and Papua from August to September.

Two new laboratory assistants were appointed in December for training to assist the Plant Physiologist.

At the end of the year the staff of the Division consisted of 4 senior officers and 26 junior staff: Head of Division, 2 Soils Chemists (1 on training course in U.K.), 1 Plant Physiologist (attached), 1 Senior Laboratory Assistant, 11 Laboratory Assistants, 1 Typist, 10 Field Assistants, 3 Laboratory Attendants.

The Soils Chemist (G. Owen) attended the Conference of the Rubber Research Institutes at Bogor in July, and discussions were held to formulate proposals for coordinating data on soils of the different rubber growing areas in the east. Three papers were contributed, 'Studies on the Phosphate Problem of Malayan Soils' and 'Determination of Available Nutrients in Malayan Soils' by G. Owen, and 'Chemical Weed Control on Rubber Estates in Malaya' by C.G. Akhurst. The first two papers were revised later in the year for publication in the *Journal of the R.R.I. of Malaya*.

Of special interest were discussions with Dr H. Greene (see page 18) and those on chemical weed control which occurred during the visit of Dr E.K. Woodford of Oxford University and Dr H. Kearns of Long Ashton Experiment Station.

A report on 'Dry Rubber Trees in North Borneo' was prepared for distribution.

The fourth issue of the New Series of *Planters' Bulletin* was devoted mainly to the work of the Soils Division and included articles on 'Weed Control on Rubber Estates', 'Manuring of Young Rubber Plants', and 'Leaf Sampling for Diagnosis of Nutrient Deficiency'.

Assistance was given to the Technical Education Scheme of the Incorporated Society of Planters by the preparation of examination questions and the marking of papers in the soils section of the agricultural science examination.

In the latter half of the year progress was made towards completion of the plans for laboratory extensions and for a glass house with associated preparation rooms. It was not possible, however, for the building operations to begin.

RESEARCH

I

SOIL SURVEY

Soil profiles were examined and sampled on two estates, one examination being made in connection with the problem of 'dry' rubber trees.

Early in the year, Dr H. Greene, Adviser on Tropical Soils to the Colonial Office, visited Malaya and officers of the Division accompanied him in Selangor and Kedah where areas of typical soils were examined. Arising out of discussions with Dr Greene, field excursions were made in Singapore on several occasions with Dr F. Elizabeth S. Alexander, geologist, to examine areas which have extremely interesting features of rock weathering and soil erosion. Of particular interest were the examples of surface deposits of 'stick' bauxite in red shale (Triassic) and secondary quartz depositions ('false teeth') in viens between iron layers in shales and sandstones exposed in heavily eroded gullies. Laboratory analyses of samples from the gully areas on Singapore Island show that the black shale has a high sulphur content and is extremely acid. The results support the theory that mangrove residues have helped to provide much of the sulphur, and under oxidation and weathering, produce very acid liquids which cause rapid solution of the rocks.

Arising out of the proposals for coordinating soil data, which were discussed in July at the Rubber Conference in Bogor, information on the description and properties of the main soil types is being prepared. Growth and yield performances of two standard clones, Tjir 1 and PB 86, will be used to help in assessing the fertility levels of soils.

II

MANURING OF HEVEA

Recording of growth measurements and yields and the application of fertilisers in experimental areas continued according to schedule. In sixtytwo experiments girths were measured, in two others heights were taken, and yield records were being obtained from fortyone experiments. Fertiliser applications were made in thirtyone areas. During the year recording work ceased on seven areas, the various reasons being damage by elephants, irregular stand due to tree losses, tree slashing and felling by bandits, and excessive age of the trees. Whereas in 1951 trees were slashed by bandits in six experiments, this happened only once in 1952. Partial damage to a manuring trial at the Experiment Station was caused by wild pig uprooting about one quarter of the plants in the experiment. One new replanting experiment was commenced in which four short term trials have been planned covering the fertiliser requirements of rubber trees during the first two years of growth.

In nursery manuring experiments where comparisons are being made of grades of rock phosphate having different degrees of coarseness, height measurements of rubber seedlings showed the normal and expected response to phosphate manuring, and in one experiment there was a suggestion that the finely ground dust was more effective than the coarser grades.

Girth measurements, taken at six inches from the ground in nursery manuring, experiments, were statistically examined and they confirmed previously reported conclusions which were based on numbers of buddable plants. Phosphate manuring, using either 1.6 oz or 3.2 oz of rock phosphate per running yard was beneficial; similar rates of application of sulphate of ammonia and half rates of muriate of potash were without any effect on the girths. Although mulching of the soil surface with cuttings of *Mikania scandens* improved the girth of the rubber seedlings the effect was not statistically significant. Differences in girth were established arising from phosphate fertiliser placed in the soil compared with application on the soil surface.

Height increments of young plants, taken during the first year after budgrafting in a replanting experiment ($3 \times 3 \times 3$, NPK) on a very sandy soil in Central Johore, showed a significant effect due to phosphate. It is of interest that there has been no established response to potash on a soil which would be regarded as potash deficient. Further information on girths will not be obtainable from this area because of the damage caused by elephants.

Interveinal yellowing of the leaves of young rubber plants is frequently assumed to be caused by lack of magnesium. Observations were made in three replantings where this type of leaf discoloration had been treated with various fertilisers, including ones supplying magnesium. In two of the areas clone PB 86 had been planted as field buddings in November 1949, and as budded stumps in February 1950; in the third experiment the trees were clonal seedlings planted at the end of 1948. Soils were different in each area, and the plants had received normal fertiliser applications prior to the appearance of the leaf discoloration. Experimental manuring failed to affect the foliage, although recovery to normal leaf colour was general in all three areas. The observations made provided no evidence to support the view that interveinal yellowing seen in the leaves of young rubber plants, particularly of clone PB 86, can be corrected by applying magnesium fertilisers. Analysis of affected leaves has shown that they are low in magnesium, and it seems probable that poor growing conditions, with low soil moisture supply and heavy competition from ground covers, accentuate the abnormal condition of the leaves which for clone PB 86 may be due to a high demand for magnesium during one stage of the clone's development.

The main bulk of the growth and yield records refer to young mature budgrafted rubber trees in experimental areas of twelve to fourteen years of age which have received two and sometimes three applications of fertilisers since the war.

From girth increment measurements the following significant responses to fertilisers in individual experiments were established:

- i* a small but marked response to nitrogen manuring was established for 1951-2; this had previously occurred for 1949-50, but not in 1950-1; there were indications, not proven, of a possible benefit from phosphate; fertilisers were given in March of 1948, 1950 and 1952 (Sungala, replanting, inland soil).
- ii* the mean effect of phosphate was significant for July 1950 to July 1951, which in earlier measurements had been suspected but not proved; fertilisers were given in May of 1948, 1950 and 1952 (Wardieburn III, replanting, inland soil).
- iii* a highly significant effect from phosphate and a significant effect from nitrogen for November 1950 to November 1951 were established; these had also been demonstrated from the measurements taken in the previous year; fertilisers were applied in 1947, 1949, and 1951 (Batu Anam, inland soil).

- iv* beneficial effects from nitrogen were established for March 1951 to March 1952; fertilisers were applied in 1948, 1950 and March 1952; (Victoria, inland soil).

There were several other experiments which gave indications of fertiliser effects, though these were not statistically significant.

Of the yield records examined a definite fertiliser effect was proved for only one replanting experiment, where a marked response to phosphate, applied in 1948 and 1950, appeared in yields for December 1950 to November 1951 (Sungala, replanting, inland soil). In this particular experiment, girth measurements have detected a response to nitrogen manuring with a suggested response to phosphate manuring.

No final conclusion on these experiments is yet possible, and must await the accumulation of further records of girth and yield. From the results so far obtained it is clear that during their first tapping cycle young mature rubber trees, which received fertilisers for two or three years from the time of planting, do not show marked yield responses to later fertiliser applications given immediately after tapping commences. Yield trends in these experiments will be of particular interest when renewed bark is tapped.

III

CULTIVATION AND COVER CROPS

Control of covers by herbicides was the main project for the year. This was an extension of the investigations commenced in 1951, which were principally concerned with lalang control. Small plot tests showed that, with the materials available, the most promising formulation comparable with sodium arsenite in effectiveness was an oil/water emulsion containing sodium pentachlorophenate and sodium trichloracetate.

Because of the difficulty in obtaining a satisfactory emulsion, extensive laboratory emulsification tests were made from which was developed the use of ammonium oleate as an emulsifier with which sufficiently stable fortified emulsions could be prepared under field conditions. Emulsification tests were made with a wide range of surface active chemicals including recognised emulsifying substances, manufacturers' proprietary compounds, and wetting or spreading agents. Few were satisfactory for the formulations used. The most effective were the ammonium salts of fatty acids (stearic, lauric, oleic, and coconut oil). When emulsions of good

stability were formed with proprietary types of emulsifiers, the high cost of the active agent made it unsuitable for the preparation of commercial sprays. Thus, with one type of anionic emulsifier, the amount needed would have cost \$66 per acre per spraying, using 100 gallons of spray liquid per acre.

Although oils with high aromatic content were easier to emulsify than the Diesel fuel type, the latter was preferred because it was only half the price of the aromatic oil. The formulation most successful in small plot trials was one with 15% oil/water, containing 1% sodium pentachlorophenate and 2% sodium trichloroacetate, with ammonium oleate as the emulsifier, and sprayed at 100 gallons per acre. If the lalang was first slashed before spraying commenced, only two or three spraying rounds were needed to kill it almost completely. Larger scale field trials, where the lalang was first burned prior to spraying, were not so successful, and four sprayings were used, followed by some forking of subsequent new shoots. The cost of the chemicals is relatively high, amounting with labour to about \$95 per acre per round of spraying.

A new weed killer, C.M.U., was tested on lalang and was found very effective. A single spraying at 80 lb per acre killed standing lalang. The optimum rate of application is probably lower, and satisfactory results may be achieved with 50 lb per acre. The present, price \$12 per lb in Malaya, is uneconomic. C.M.U. is a p-chlorophenyl dimethylurea, available as a wettable powder.

The experiment to shade out lalang with quick growing tree species has shown that, of the twelve plant species and methods of planting, Cashew nut (dibbled seed), Kemanyan seed (broadcast), and Tembusu seedlings (planted), have the greatest numbers of survivors after nearly three years from planting; Casuarina and Batai have the best growth rate but do not give a large amount of shade. Observations are continuing.

The field tests and observations have been made on the use of sprays for controlling other types of covers beside lalang and the following effects have been recorded. The broader leaved types of bush are more susceptible to 2,4,5-T compounds. Siam weed (*Eupatorium odoratum*) has been killed by spraying with 0.1% solution of the sodium salt of 2,4,5-T acid, and in other trials Siam weed was effectively killed after two sprayings with Trioxone used at the rate of $2\frac{1}{2}$ lb per 100 gallons of spray liquid. Bracken or resam (*Gleichenia linearis*) was killed by spraying with 0.66% Trioxone. It was also killed with 5% solution of Fernoxone, and two sprayings with 1% sodium arsenite solution were equally effective. Straits rhododendron (*Melastoma polyanthum*) when

sprayed with sodium arsenite or sodium trichloracetate is usually only defoliated, but stagmoss (*Lycopodium cernuum*) has been killed by spraying with 1% sodium arsenite. During tests with sodium trichloracetate and Trioxone for spraying roadside belukar at the Experiment Station, accidental drift of the sprayed liquid across the road caused defoliation of rubber seedlings for three to four chains in from the road edge, in a mature rubber area.

Towards the end of the year an experiment was commenced to test the value of various types of herbicides as pre-emergent sprays for reducing weed control in rubber seedling nurseries.

IV

MECHANICAL CULTIVATION

The experiment combining soil cultivation with manuring continued at the Experiment Station in Field 15. Fertilisers were applied and were followed with ploughing and harrowing treatments of the soil for the third year in succession, but the treatments have so far been without any effect on the yield, girth or appearance of the 20 years old rubber trees.

Lalang eradication between planted hedges of young rubber, in Field 54 at the Experiment Station, was successfully achieved by ploughing and harrowing. The initial density of the lalang necessitated a flattening by the disc harrow before the cultivation treatments were started. The flattened lalang was then disc ploughed and immediately harrowed. After an interval of ten days a second treatment of ploughing and harrowing was given. From May to July about fifty acres were treated in this way and fuel and labour costs amounted to approximately \$40 per acre. It resulted in a quick eradication of the lalang and subsequent control was by a monthly lalang patrol.

V

LABORATORY INVESTIGATIONS

New methods of analysis were examined from time to time during the year. The colorimetric determination of potassium in solutions was investigated without reaching any successful conclusion. Comparisons were made of methods for determining total exchangeable

metal cations and total exchange capacity of soils. Biological and chemical methods were examined for determining available nutrients in soils, and satisfactory techniques were evolved for determining copper in soil by chemical analysis and by bio-assay. Towards the end of the year special attention was given to methods of analysis of plant material and in particular, the determination of magnesium, potassium, manganese and zinc.

Summary of Laboratory Work

SOIL SURVEY	Samples	Determinations
Mechanical and chemical analysis of experimental soils	145	2848
Other samples	86	688
ADVISORY		
Soils	128	1258
Fertilisers	10	78
Plant materials	85	724
Miscellaneous	9	56
INVESTIGATIONS		
Ammonium and nitrate-nitrogen in soils	130	924
Fertiliser leaching	180	1156
Available nutrients in soils	43	487
Analysis of rubber seedlings	145	1486
Phosphate studies	68	1663
Cation exchange	7	321
Leaf analysis methods	159	1925
Arsenic toxicity	70	140
Copper bio-assay	25	25
Sand acid extractions	25	161
Water analysis	3	18

Distribution of various forms of phosphate in soils — A study was made of the distribution of acid soluble and alkali soluble phosphate fractions, *i.e.* native phosphorus, in untreated soils. The soils examined may be broadly classified on the basis of their phosphate status and response to treatment with fertilisers as:

- a inland loams and clay loams, mainly highly ferruginous and showing marked response to phosphates;
- b inland sands and sandy loams, responsive to phosphates;
- c coastal alluvial clay loams and peaty loams, giving no response to phosphates.

SOILS DIVISION: RESEARCH

A summary of the information obtained is given below, the values being for p.p.m. of P_2O_5 :

	<i>Acid soluble fractions</i>	<i>Alkali soluble fractions</i>
Soils responsive to phosphates.	Usually less than 10 p.p.m. Sandy soils may contain more. Values greater than 15 p.p.m. are exceptional.	Values range from 0 to 46 p.p.m.
Soils which do not respond to phosphate treatment.	Usually greater than 15 p.p.m. Lower values are exceptional.	Usually greater than 25 p.p.m. and may be as high as 280 p.p.m.

A relatively large proportion, ranging from 30 to 52%, of the total phosphorus in all the soils was associated with the soil organic matter; it is not known to what extent this organic phosphorus fraction contributes to the phosphate nutrition of plants, although it forms a reserve supply from which available forms will be gradually released.

A study has also been made of the distribution of added phosphate in soils one year after treatment with four different phosphate compounds, one of which was rock phosphate and the other three were soluble phosphates. Results indicated that phosphates added to soils are converted into different forms, some of which are more tightly held than others, and the distribution of the various forms of phosphate differs widely according to soil type. The final distribution of various forms appears to be independent of the type of fertiliser applied. The results suggest that, for sandy loams and possibly coastal alluvial clay soils, fixation as absorbed phosphate and precipitated basic phosphate of iron and aluminium proceeds rather more rapidly with soluble phosphatic fertilisers than when rock phosphate is added.

Estimation of the readily available fraction of native phosphorus in soil — A comparison was made of two laboratory methods for routine estimation of available phosphate in local soils. Truog's method which uses dilute sulphuric acid was compared with that of Bray and Kurtz, which extracts phosphate with dilute hydrochloric acid and ammonium fluoride. The Truog method gives low values which fall within a narrow range for all soils (2 to 22 p.p.m.). Values obtained by the fluoride extraction method fall over a much wider range (2 to 57 p.p.m.) and permit a more reliable assessment of the phosphate status of different soils. The

threshold value, below which a response to treatment with phosphate is to be expected, can be fixed with greater precision, and for soils in rubber areas may be put at 25 p.p.m. P_2O_5 . For a reliable comparison of the phosphate status of soils in different areas the method of soil sampling has been arbitrarily standardised by taking a composite sample to a depth of six inches from several points in any one area.

Movement of phosphate added to soil — Phosphate was intimately mixed with the surface of a column of soil, which was then frequently leached with water. No phosphate was recovered in the leachate, and there was no movement of phosphorus in an inorganic form into the horizons below that in which the phosphate was put.

Nitrogen studies — Determinations of nitrogen fractions and moisture contents in soil samples collected weekly from bare plots and from covered plots were completed for a period of one year, and the general conclusions drawn from the observations are:

- i no marked seasonal fluctuations occur in the ammonium and nitrate nitrogen in local soils; such variations as were obtained are too small to be of any practical significance.
- ii mulching with cuttings of lalang grass does not enhance the content of soluble nitrogen in the soil; this may be due to the high carbon nitrogen ratio of the mulch.
- iii conditions for maintaining a constant supply of soluble nitrogen are best in a soil which is effectively covered by a growing creeper.

As expected, the moisture content of the soil in the covered plots (both mulched and with growing creeper) was consistently higher than in the bare plots. The difference was most marked in the surface soil and was accentuated in dry spells. The mean moisture content in the surface soil throughout the year was 4.4% higher in the plots covered with creepers than in the bare plots, and this difference emphasises the value of maintaining an effective cover over the soil.

Carbon and total nitrogen, including nitrogen in the soil organic matter, were determined on samples collected from the plots over a period of five weeks. From the values obtained it has been estimated that the content of humus in the top seven inches of the soil is about five times per acre more in the plots under creeping cover than in the uncovered soil. Similarly the estimated total nitrogen content is greater in the soil under creeping cover than in the bare soil by as much as 4 cwt per acre, which is equivalent to about 1 ton of sulphate of ammonia.

Leaching of fertilisers—Information was sought on the losses of fertilisers from soils which could be expected to occur under average wet weather conditions, and columns of soil containing the fertilisers were leached at four day intervals for a month and subsequently at weekly intervals. The fertilisers (nitrate of soda, sulphate of ammonia, urea, muriate of potash) were intimately mixed with soil in the top two inches of the columns. The completed observations showed that:

Nitrate of soda was lost from the soil in the first four leachings;

Sulphate of ammonia was lost firstly as ammonia-nitrogen, 65% of the added nitrogen being removed in this form after nine leachings; and secondly as nitrate-nitrogen, 34% of the added nitrogen being washed out after 18 leachings;

Urea: losses as ammonia-nitrogen amounted to 38% mostly during the earlier leachings and ceasing after the ninth leaching; losses as nitrate were 47% of the total added nitrogen and extended up to the eighteenth leaching;

Muriate of potash: after 22 leachings, 90% of the potash had been lost.

For soil treated with urea, the leaching of added potash proceeded at a retarded rate, but the other nitrogen fertilisers had no effect on the rate of leaching of potash. The observations confirm the general opinion that under leaching nitrate of soda is easily lost from the soil, and that urea is relatively slow to disappear. Sulphate of ammonia occupies an intermediate position, but may all be lost in three to four months.

Pot culture work — Rubber seedlings were grown in sand cultures receiving daily additions of nutrient solutions, and at the end of a year the plants were harvested and records taken of dry weights and of rubber hydrocarbon content. Growth responses, measured by total dry weights, were highly significant under nitrogen and phosphorus nutrition, but potash had no effect on the growth. Without nitrogen all plants grew very poorly and phosphorus was not beneficial; in the presence of adequate nitrogen, phosphorus had a highly significant benefit to the growth.

The amount of rubber hydrocarbon in the plants followed closely their total dry weights and, when expressed as weight of rubber per unit weight of plant analysed, no effect of the nutrients was established. This supports the view that fertilisers may have no effect on yield of rubber trees independent of their effect on growth and any yield benefits arise indirectly as a result of the

improvement of growth. Within the plant, the rubber hydrocarbon was most concentrated in the green bark and in the leaf petioles and, from the total amounts found in different parts of the plant, the leaf petioles appear to be the most suitable material for studying relative latex contents of young rubber seedlings.

A study was also made of the effect of the added nutrients on the distribution of major plant nutrients in the stem wood; several interaction effects were established.

Arsenic toxicity in local soils — Tests were made in the laboratory with local soils which had been treated with sodium arsenite to measure toxicity using a plant indicator method, degree of arsenic fixation, and amount of arsenic removed by leaching. The results showed that for a range of soil types, the concentrations of arsenic required to produce toxicity in a soil, as measured by the survival of *Centrosema pubescens*, would have to be from three to twelve times as great as the amount applied in eight spraying rounds. Symptoms of toxicity noted in *Centrosema pubescens* plants grown in treated soils indicated that after allowing for leaching by rain water and for retention or fixation of arsenic by the soil, at least 50 rounds of spraying (2½% sodium arsenite) will be required to produce toxic conditions on light sandy loam soils.

From 45 to 92% of the arsenic added can be retained by a soil, and a given weight of soil can fix up to 0.5% of its weight of arsenic oxide (As_2O_3). Percolation tests gave no arsenic in the leachate, except for slight traces from sandy soils.

Padi seedlings were also used for testing toxicity and both these and *Centrosema pubescens* seedlings can contain up to 50 p.p.m. As_2O_3 before they show signs of harmful effects.

Estimation of available nutrients in soils — For the estimation of available phosphate and potash in soils comparisons were made between chemical and biological methods. For potash, close correlation was obtained between the exchangeable potash extracted by dilute acetic acid and the values given by the *Aspergillus* method and the Neubauer method, and it is assumed that the chemical method of estimating exchangeable potash gives a reliable assessment of the relative levels of potash in local soils.

Available phosphate in soils was also estimated by the same two biological methods, as well as by the chemical methods of Truog and of Bray and Kurtz. Neither of the biological methods was found satisfactory, because the values obtained were extremely low and fell within a narrow range. A significant correlation was established between the Truog value and the *Aspergillus* values, but not between the Truog values and the Neubauer values.

SOILS DIVISION: RESEARCH

Growth of the mycelium was poor in tests with all the soils examined, and no clear discrimination was possible between soils which respond and those which do not respond to phosphates.

The fluoride extraction method of Bray and Kurtz gave results having a high correlation with those of the Truog method and which, by covering a wider range of figures, allowed better discrimination between soils. Statistical examination of the figures showed that there is a good chance that young rubber trees will respond to treatment with phosphate when there is less than 25 p.p.m. extracted from the soil.

Available copper in soils was determined satisfactorily with a bio-assay procedure, using *Aspergillus niger* (M), and in connection with this, the estimation of total copper was successfully carried out by a chemical method, using dithizonate.

Exchangeable cations in soils—Quicker methods for determining total exchangeable metal cations and total exchange capacity of soils were tested.

Leaf analysis and nutrient studies—In cooperation with the Plant Physiologist attached from the Botanical Division an extensive programme of nutrition studies was planned and the initial work was commenced for the projects listed:

Methods of analysis of plant tissues, with particular reference to magnesium, potassium, manganese, and zinc;

Leaf sampling technique;

Diurnal variation in nutrient content of rubber leaves;

Chemical composition of leaves of different clones;

Chemical composition of bark as a means of assessing the nutrient status of mature rubber trees;

Improved methods of estimating rubber in leaves;

Evolution of techniques for chlorophyll, sugar and auxin determination in rubber leaves;

Pot culture technique and preparation of containers, sand, water supplies, and nutrient solutions;

Chemical composition of rubber leaves classed as 'genetic yellows'.

Other subjects which received attention during the year were the colorimetric determination of potassium in solutions, rubber hydrocarbon content of bark of 'dry' rubber trees (in conjunction with Botanical Division), and effect of liming of soil on the growth of younger rubber plants and on the composition of the leaves.

ADVISORY

THE STATISTICS RELATING TO CORRESPONDENCE and visits. are summarised :

<i>Letters sent out</i>	
advisory	381
experiments	281
miscellaneous	59
Total	721

<i>Visits to estates</i>	
advisory	20
experiments	37
miscellaneous	17
<i>Visits to R.R.I.E.S.</i>	51
Total	125

Over the whole year, the number of letters sent out showed no appreciable change over the figure (713) for 1951. The principal subjects dealt with were weed control and the use of weed killers, manuring of backward young rubber trees, foliage discoloration and abnormalities, and manuring of mature trees.

Visits were greatly increased to experimental areas on estates and to the Experiment Station and in the latter instance were due to new spraying tests which were commenced. Interviews and discussions held at the Institute on matters concerning the work of the Division amounted to 158.

MANURING

Manuring problems in young rubber were related principally to the means of improving growth of backward trees and to curing foliage discolorations and abnormalities. Potash and magnesium deficiencies and poor growing conditions account for much of the foliage peculiarities of younger rubber trees. Low soil moisture supply, heavy competition from ground covers and the use of pockets for fertiliser applications before the rubbers feeding roots are adequately developed have been other causes of poor growth.

For mature trees, advice was usually sought on the need for the use of fertilisers during early maturity and whether older mature trees should be manured or considered for replanting. A programme of repeated fertiliser application over a period of years is usually necessary to maintain any initial yield stimulation in old mature rubber trees but, at the best, such applications can only raise yields to the capacity of the trees as determined by their genetical constitution.

SOILS DIVISION: ADVISORY

WEED CONTROL

Control of different types of cover in young rubber areas has been the subject of numerous estate inquiries, and grasses have proved to be the most difficult to eradicate. Because of their hardness grasses survive where softer broad-leaved plants are more readily controlled by changkol scraping or by chemical weed killers. Straight oil sprays and sodium arsenite solutions give partial control of grasses but the scorching effect is only temporary. The chemically fortified oil emulsions give better results but as yet cannot be recommended for routine estate practice. Such emulsions can be successfully prepared and used by ordinary contract labour; they are relatively non-poisonous (sodium pentachlorophenate irritates the eyes and throat) and only a short period is required for treating the grass.

The plant hormone type of weedkillers (2,4-D and 2,4,5-T compounds) are being used for specific weeds (page 22). Particular success was reported from an estate near Taiping where water hyacinth (*Eichornia crassipes*) occurs on water canals. It was killed by a single spraying of Fernoxone at 10 lb per acre in 100 gallons of water, with a spreader included. *Mikania scandens* has also been eradicated using Fernoxone at 2 lb per 100 gallons of water. A less responsive creeper is the sensitive plant *Mimosa pudica* which is only partially killed by Trioxone, although more success was obtained with two sprayings of sodium arsenite at 1½% concentration with three weeks' interval between sprayings. According to reports it may also be killed with Agroxone sprayed in a solution containing 12 pints to 100 gallons of water.

MECHANICAL CULTIVATION

Observations made on estates from time to time have shown that light powered wheel tractors of the Ferguson type can be successfully used with attachments, some of which have been home made, for weed control in young and old rubber areas. Raking with a single tine will remove creepers along the edges of cleared planting rows in young replantings. Heavy chains or short lengths of rails are effective in breaking down heavy lalang prior to ploughing it in, and a length of girder iron, convex in shape and attached to the front of the tractor, will knock down bush covers in mature rubber as a substitute for hand slashing. On land which has been cleared of lalang by ploughing and harrowing prior to planting the

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use of a single pronged subsoiler, set at maximum depth, was found to be an adequate substitute for planting holes.

C.G. AKHURST
Head of Soils Division

BOTANICAL DIVISION

Dr E.D.C. Baptist was on home leave from May to December during which time Mr H.M. Burkill acted as Head of Division. Mr Burkill, Mr Brookson and Mr de Jonge were on duty throughout the year. Mr T.V. Vaidyanathan, Assistant Botanist, returned from long leave in India and resumed duty in March.

Dr E.W. Bolle-Jones, a member of the Agricultural Research Council Plant Nutrition Scheme at the Agricultural and Horticultural Research Station, Long Ashton, Bristol, was newly appointed in August as plant physiologist for research on nutrition of hevea. Owing to administrative changes made since his appointment Dr Bolle-Jones will be attached to the Soils Division with effect from January 1953; his work is closely linked with the nutrition studies in the research programme of the Soils Division but close liaison will be maintained with the Botanical Division.

Dr J.S. Lowe was appointed as plant physiologist for fundamental research on the physiology of latex formation. Dr. P.R. Wycherley was appointed as plant taxonomist for a special study of the taxonomy of hevea and at a later date for secondment to America for liaison work with Officers of the U.S.D.A. Division of Rubber Plant Investigations and of the Departments of Agriculture in the principal rubber growing countries of Tropical America. These two officers are expected to arrive in Malaya early in 1953.

Mr V.K. Bhaskaran Nair assumed duty in May as Assistant Botanist.

With the appointment of these new officers the staff of the Division will consist of 6 senior officers, 2 graduate assistants, 9 laboratory assistants, 13 field assistants and 2 laboratory attendants.

The R.R.I. was represented at two conferences during the year under review. Dr E.D.C. Baptist, while on home leave, attended the XIIIth International Horticultural Congress held in London in September and presented, as a contribution from the Botanical Division a paper entitled 'Recent Progress in Malaya in the Breeding and Selection of Clones of Hevea Brasiliensis'. Mr C.W. Brookson and Mr P. de Jonge attended, with other members of the R.R.I. the conference of Rubber Research Institutes held at Bogor, Indonesia in July and presented three papers contributed by the Botanical Division.

Mr C.W. Brookson lectured in June to the Kedah South & Province Wellesley Branch of the Incorporated Society of Planters and in October to the North and Central Kedah Branch of the Incorporated Society of Planters on 'Choice of Planting Material'.

In connection with experimental planting on estates research officers spent altogether 99 days and field assistants 249 days on estates. Research officers paid 247 visits to the R.R.I. Experiment Station and members of the junior staff from headquarters visited the Experiment Station 73 times.

The first issue of the New Series of *Planters' Bulletin* appeared in July and was devoted to articles from the Botanical Division, namely 'Poisoning Rubber Trees with Sodium Arsenite', 'A Comparison between Alternate-Daily A.B.C. (Periodic) and Third-Daily Tapping Systems', 'A Note on Hevea Spruceana' and 'Note on Clone LCB 1320'.

RESEARCH

I

BREEDING AND SELECTION

HAND POLLINATIONS

A total of 7500 hand pollinations consisting of ten families of out crosses, twelve families of back crosses, two families of sibling crosses and two families of selfs to give twenty-six families of seedlings had been planned for the 1952 breeding programme. Despite the fact that flowering was delayed by unseasonable wet weather and that the trees of one of the main parents (RRIM 612) were defoliated by a spray mist from a nearby roadside spraying experiment, 6419 hand pollinations were carried out.

Three families of out crosses and ten families of back crosses were obtained giving a final success of thirteen seedling families with 213 fruit harvested (3.3%) and 534 seed germinated. It was observed that fruit on clone RRIM 616 took much longer to mature than fruit on the other clones used in this programme. The cross RRIM 527 $\times$ PB 49 produced no seed out of 430 pollinations.

The number of seed germinated ranged from 132 in the family RRIM 616 $\times$ Tjir 1 to 7 in the family RRIM 610 $\times$ Tjir 1 with eight families showing less than 50 seedlings. Such a small number of seedlings per family renders any attempt to evaluate the seedlings or the parent clones unreliable in statistical trials. As a preliminary measure to further programmes, more hand pollinators are being trained and a threefold increase in the number of pollinations made is to be aimed at to ensure that at least 30 fruit or

90 seed of each legitimate seedling family are obtained. To accommodate the expected increase in seedlings in 1953 the hand pollination nursery enclosure has been extended to approximately double its former size and provision has been made for further extension. In view of the low percentage success obtained a further investigation of hand pollination technique is considered desirable.

The hand pollination programme envisaged for 1953 includes only out crosses of clones Tjir 1, PB 49 and AVROS 157 with imported clones found to be good seed parents by other Rubber Research Institutes. These clones are Dj I, War I, War 4, PR 107 and LCB 1320. A number of minor crosses are also envisaged.

A preliminary trial to preserve pollen at a temperature of 0° C for periods varying from 9 to 11 days has not been successful. Out of 450 pollinations made, 150 on each of the ninth, tenth and eleventh days of storage, only one success has been obtained.

SEEDLING FAMILIES

Of nine families of the 1950 hand pollination programme 188 seedlings were planted out at the Experiment Station. The trial was arranged in three blocks and one third of the total number of seedlings in each family were planted out in each block after randomisation. The seedlings are planted at 20 ft × 20 ft and are surrounded by unselected seedlings. The whole area is surrounded by control rows of budded stumps of clone RRIM 501 at a stand of 20 ft × 10 ft. Owing to the exceptionally favourable weather experienced after planting both seedlings and buddings were growing well at the end of the year.

The four seed gardens totalling 191 acres, developed by the Botanical Division on the Experiment Station under Colonial Development and Welfare Scheme D. 1176 for the large scale production of improved seed for smallholders, passed to the control of the Smallholders' Advisory Service from the beginning of the year. Five clones, reported or proved good seed parents, are represented in each garden and are selected from clones RRIM 501, 509, 526, 527, PR 107, AVROS 157, PB 49, TK 14 and BR 2, with clone Tjir 1 common to all gardens. Some fruit was observed at the end of the year especially on trees of clones AVROS 157 and BR 2 which were then approximately two years of age from budding.

Seedlings of an importation from tropical America established at Kuala Lumpur in May 1951, and known as the R.R.I. 1951 Collection, had successfully passed through a period of quarantine

by the end of the year; clones will be made from a selection of the most vigorous plants for budding in a trial on the Experiment Station in March/April 1953. A cubic lattice design was prepared in cooperation with the Statistician to test 343 of these clones in a more rigid experiment than the usual small scale clone trial. There were, at the end of the year, 580 seedlings in the collection of which 213 are of *Hevea benthamiana* and the remainder, with one exception, are of *Hevea brasiliensis* from two different regions of tropical America.

A trial budding carried out on a small number of plants has shown that the percentage of 'takes' of buds of *Hevea benthamiana* on seedlings of *Hevea brasiliensis* is of the same order as that of *Hevea brasiliensis* on stocks of the same species. Growth of all seedlings was good at the end of the year.

A second importation made during 1952, known as the R.R.I. 1952 Collection, was established during the year. Growth was not good and a number of casualties occurred but there remained at the end of the year 457 seedlings composed of 174 *Hevea brasiliensis*, 268 *Hevea spruceana* and 15 *Hevea pauciflora*.

Seed of a *Dothidella* resistant clone FX 25 with various eastern clones as pollen parents was received in September 1952 from the United States Department of Agriculture Breeding Station at Summit, Canal Zone, Panama. Growth was not good, but about 275 seedlings had been established successfully at the end of the year.

The seedlings of the *Hevea brasiliensis* families from the two sources in tropical America which lie at opposite ends of the *Hevea brasiliensis* cline may prove useful for breeding, after testing and grading up. It is possible, although improbable, that some resistance to South American leaf blight caused by the fungus *Dothidella ulei* may be found in one of the families. The seed of clone FX 25 may prove to show some resistance to *Dothidella ulei* although the yield is expected to be poor. The value of the other families is purely nominal.

CLONES

From the seedlings of the 1950 hand pollination programme previously referred to, 176 new clones were prepared. Each was budded in a plot of twelve points and every eighth plot was budded with clone RRIM 501 as a control. No new clone is, therefore, on the planting distance of 20 ft $\times$ 10 ft employed, more than 80 feet away from a control. The buddings were cut back and have grown away well. Very little supplying was required.

A museum block was prepared at the Experiment Station to contain all the old clones represented on the station and the new clones acquired since 1946. Such a concentration facilitates hand pollination work, and also releases the old museum block for re-planting in a few years time. By the end of the year 232 clones had been budded in plots of twelve trees. An area of five acres on the Experiment Station was budded as an exhibition plot with clone PR 107 (LCB 510). Budded stumps of clones LCB 1320 and RRIM 520 were planted in one acre plots in unused corners of another field.

An examination was made of selfed seedlings of clone Tjir 1 which had been treated in September 1950 by immersion of the growing point of the plumule for twelve hours in a 0.4% solution of colchicine with the addition of the wetting agent Dispersol L; sixty-nine of the seedlings showing growth abnormalities were made into clones. Basal buds were removed and six buddings of each clone were made for observation and examination at a later stage for evidence of polyploid tissue.

From legitimate seedlings of the 1937 to 1941 series of crosses, 153 clones were made and established in small scale trials, under observation for possible selection as RRIM '600' series clones. Of these 31 have already been selected and established in large scale trials. One further examination will probably complete the selection of clones prepared from these hand pollinations.

It is becoming increasingly apparent that one of the criteria for good selection is an examination of the physical properties of the latex and of the raw and vulcanised rubber of each clone. It is hoped that these tests can be carried out on the clones which remain under observation before any further selection is made.

Clone PB 86 is reported to show some measure of resistance to *Oidium* in Ceylon and 16 clones made from its legitimate progeny have been sent to the R.R.I. of Ceylon for tests of resistance to *Oidium* and of yield performance. These clones are also included in the 153 clones under observation for further selection.

Of the twenty-five *Dothidella* resistant clones which are being supplied to Malaya by the Instituto Agronomico do Norte, Belem, Para, Brazil, in exchange for the same number of RRIM '500' and '600' series clones, twenty-four are now established at the United States Department of Agriculture Plant Introduction Garden, Coconut Grove, Miami, Florida. The growth of the buddings of about twelve of these clones is now sufficiently advanced to provide good budwood early in 1953 when the budwood will be despatched by air to Malaya via the Commonwealth Mycological Institute, Kew, England.

RRIM '600' SERIES

During the year the selected RRIM '600' series clones in small scale trial at the Experiment Station maintained a satisfactory increase in girth and yield; the following clones yielding over 25 pounds per tree: RRIM 600, 603, 605, 608, 610, 615, 618, 622 and 623. Three of the six trees of clone RRIM 600 have been affected by brown bast since they were opened for tapping in 1947. The yield increase of clone RRIM 619 has proved disappointing; it gave only 2.5 pounds per tree more than the control clone Pil B84 in the sixth year of tapping.

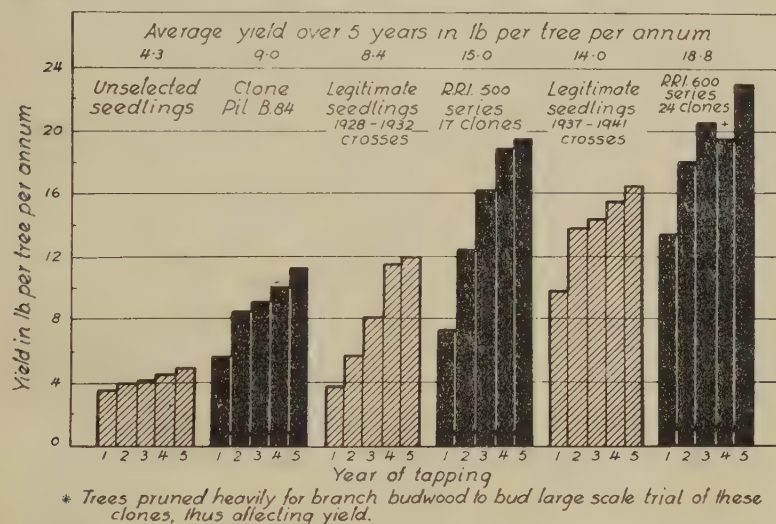
Clone RRIM 612 continues to be the most vigorous clone with an average girth of 41.4 inches at an age of thirteen years from budding. It has excellent virgin bark and rate of bark renewal and shows freedom from brown bast. Clones RRIM 624 to 630 were selected from fields which were old elephant belts between mature rubber and the jungle. They suffered badly from neglect during the Japanese occupation and their growth was suppressed. After selection for the RRIM '600' series, trees of clones RRIM 624 to 627 were slashed by terrorists in June 1951 and no further yield results are available. Of the remainder, clone RRIM 628 appears to be the most promising. Further comments on these late selections of RRIM '600' series clones will be reserved until yield data are available from the large scale trials.

In a large scale trial of clones of the first selection of the RRIM '600' series (RRIM 600 to 618) the following observations were made after a severe storm during the last quarter of the year: clones RRIM 603, 613, 616 were the most affected, with minor damage occurring in clones RRIM 607, 608 and 615. Most of the trees of these clones were blown into a leaning position, no breaks occurring, and the leaning trees are now held in an upright position by means of guy ropes. Clone RRIM 616 showed slight mechanical damage, with small streaks of coagulated latex on the stem; this clone has a heavy crown with spreading branches and as 26 trees out of 350 were leaning, the lower branches of all trees were pruned. Out of 350 trees, 66 were similarly affected in clone RRIM 603, which has a heavy crown with erect and well spaced lateral branches and a straight trunk. Only 13 trees were affected in clone RRIM 613, which has a light crown with many lateral branches arising from the same level on the main stem.

Supplies of latex collected from the RRIM '500' and '600' series clones were examined in the Chemical Division for mechanical stability and other properties. For the preparation of centrifuged latex concentrates the latices of clones RRIM 508, 511, 513, 516, 526, 601, 606, 607, 609, 612, 614, 615, 617, 620, 622, 623

and 629 were very suitable, those of clones RRIM 520, 602, 603, 604, 611 and 630 were probably suitable and those of clones RRIM 501, 519, 521, 527, 600, 605, 608, 610, 613, 616, 619, 621 were unsuitable. These results need to be confirmed by using latex from other areas, when available. The properties of smoked sheet from these clones are also being investigated.

At the end of the year the RRIM '600' series clones had been established in three large scale trials on the Experiment Station and in twentyone dispersed trials on estates. In addition thirteen large scale trials were budded on estates during the year. Results from small scale trials indicate the improvement which may be expected from these clones as a result of selection, breeding and further selection and these results are presented in the histogram. It is apparent that a continuous improvement has been achieved in both the seedling families and the clones produced by the R.R.I. The reason for this is fairly obvious. Unselected seedling material can be taken as the lowest common denominator of all rubber planting material and the RRIM '500' series clones were made from legitimate seedlings obtained by crossing clones prepared from a restricted range of unselected seedlings.



The RRIM '600' series clones on the other hand were made from seedlings produced by crossing clones which were reputed to be the best parents in south east Asia and appear to be superior to the RRIM '500' series clones. Crossing between the RRIM '500' and RRIM '600' series clones might be expected to show a further increase in yield. Further the range of the best parents in south east Asia has not been exhaustively explored and the clones

selected for the 1953 breeding programme may produce progeny of high quality if reports of their performance as parents are confirmed. There appear therefore to be reasonable prospects of ennobling still further the eastern strains of hevea, but the yield increase is not expected to be as spectacular as that already achieved.

METHODS OF EARLY SELECTION

Gunnery's findings at the R.R.I. in 1935, of the relationship between sieve tube diameter and yield, are being verified on bark samples taken from legitimate seedlings of the 1949 and 1950 series of crosses. Measurements of sieve tube diameter in bark of 304 trees of the 1949 crosses have been completed and samples of bark have been taken from 176 trees of the 1950 series of crosses and preserved preparatory to sectioning for sieve tube examination.

A method of yield prediction at an early age is being investigated. In this Preliminary Test a standard incision is made on a young plant at a constant height from the ground on each of three alternate days and the latex exuding from each incision is collected and dried to constant weight. Results obtained from legitimate seedlings of the 1950 series of crosses suggested that the variability between seedlings is more marked in some families than in others and the distribution tended to be skew. Differences between seedling families were not established because of the relatively large tree variability within a family. Replication of the test showed considerable variation and led to little increase in precision. These same trees are to be examined for sieve tube diameter in an attempt to relate these two characters.

The tests have been carried out on young buddings of the RRIM '600' series clones in large scale trial and it is intended to correlate these results with those of the ten day test tapping and later with the yields of the clones in regular tapping.

II

PROPAGATION AND PLANTING TECHNIQUE

Experiments with hevea leaf cuttings, with and without an axillary bud, carried out by the writer have given promising results. Young plants raised at the Cambridge Botanic Garden afforded opportunity for a preliminary trial in 1949.

Leaves plucked from the plants and planted in a mixture of sand and leaf mould were rooted successfully from the basal end of the petiole.

The experiment was repeated by the writer while on home leave during the summer of 1952 in the quarantine house at Kew Gardens. Leaf cuttings, with the axillary bud in the heel cut away from the young stem, were planted in a mixture of silver sand and peat moss contained in a frame in the heated glass house. They remained in a fresh condition two months after planting and formed a callus with root initials plainly showing when the writer left to return to Malaya in November 1952.

These experiments will be resumed at this Institute in 1953 and extended to include treatment with a wide range of synthetic growth substances.

With the present frequent despatch and receipt of hevea planting material by air the effect of chilling or freezing on the germinative capacity of seeds has been studied. The results indicate that there may be a loss of viability of seed frozen for 24 hours. The germination capacity of seed frozen for 12 hours or chilled for 12 to 24 hours was not adversely affected. Seeds were killed on chilling in solid carbon dioxide for six hours.

An assurance is always obtained from the air lines to the effect that budwood despatched by us to the European, African or American continent is always carried in pressurised freight compartments. As the material is bulky and the cost of air freight high a further series of experiments is being carried out in co-operation with the Pathological Division, with a view to finding a practical method of sterilising and preserving bud slips in a viable condition for periods of up to 20 days, as might happen if this form of budding material is in transit over long distances with several changes of aircraft. Treatment of the bud slips with suitable fungicides would reduce the risk of disease introductions into the importing countries.

The old practice of opening the seed coat to improve germination has been investigated. Germination successes may be increased 20 to 30 per cent by cracking the seed coat or by opening the micropyle but the former method, leads to deformation of the radicle. Piercing the seed with a 2 mm diameter hole did not affect the percentage germination. The advantage to be gained by opening the micropyle of the seed coat is most important, especially with expensive clonal seed or valuable seed from hand pollination work.

Tapping and yield recording continue in experiments designed to study the relationships of stock and scion. The results obtained

so far have been analysed statistically and are being prepared by the writer for publication in the *Journal of the R.R.I. of Malaya*.

A top budding experiment is in progress to test the effect of the crown on the middle piece of double budded trees. The first budding at the normal height was carried out in March. Clones Tjir 1, BD 5, LCB 870 and a clone of *Hevea spruceana* will be used in all combinations when the high buddings are carried out at about eight feet from the ground during the autumn of 1953.

Data from the density of planting experiments are being summarised for statistical analysis with a view to publication in 1954.

An experiment has been established on the Experiment Station to compare three hedgerow spacings of 50 ft, 65 ft, and 80 ft, with planting intervals along the rows to give three planting densities of 150, 195, and 245 trees per acre, with forms of avenue planting and rectangular planting giving an initial density of about 180 to the acre. Budding will take place in 1953. The design of the experiment will allow a critical examination of the conflicting reports published on the hedge system of planting.

The trial of mixed planting of rubber and cacao on the Experiment Station has been kept under regular observation during the year. Growth of the cacao remains good in the 'jungle' planting but patchy in the open. Considerable damage to the cacao pods has been caused by squirrels.

Budding has now been completed in three of the four main treatments of replanting experiment which compares different methods of reducing the unproductive period that occurs between the removal of the old stand and the bringing into tapping of the new. There would appear at this stage to be little to commend any of the treatments tried in preference to the conventional method of removing the old stand before replanting.

III

TAPPING

Seven tapping experiments are in progress on the Experiment Station and five on estates. The oldest of our experiments on full circumference tapping was started in August 1953 on unselected seedling trees planted in October 1928. In this experiment the trees on the double four system (2S/2.d/4.100% in which two half circumference cuts on opposite sides of the tree are tapped every fourth day) and on the full spiral fourth daily system (S/1.d/4.100%) have yielded about ten per cent more than the half

spiral alternate daily system (S/2.d/2.100%) over the full period of yield recording of the experiment, with possibly a slight advantage in favour of the full spiral fourth daily system.

A comparison of the double four system with the standard system of one half circumference cut tapped on alternate days has been in progress since July 1937 on budded trees of nine clones. This is our oldest experiment on full circumference tapping of budded trees. Expressed as a percentage of the control the yields on the double four system which were 127 in 1937 declined rapidly to 90 in 1939 and in 1952 remain well below the control at 77 per cent. The clones vary considerably in their response to double four tapping; clone AVROS 50 showing no decline in yield during the postwar period 1946-52 whereas the yield of clone Pil A44 is only about 65 per cent of that of the S/2.d/2.100% system. The average result for all clones over the period has been a loss of yield of about 23 per cent and a loss of girth of nearly 4 inches on the double four system.

In another experiment the effect of full spiral fourth daily tapping on budded trees of sixteen clones after 5 years' continuous tapping is shown by a smaller yearly girth increment than in half spiral alternate daily tapping (0.28 in. compared with 0.44 in.), by a higher proportion of lower grade rubber (18% of total yield compared with 14%) and by a slightly higher incidence of brown bast (3.6% compared with 3%). During the first five years of tapping the half spiral alternate daily system (S/2.d/2.100%) yielded an average excess of 1 lb per tree per year of No. 1 rubber and $\frac{1}{2}$ lb per tree per year of total rubber (including lower grades) over the full spiral fourth daily system.

A comparison of the full spiral fourth daily continuous system with periodic (ABC and ABCD) systems of 67% and 75% relative intensity on mature buddings of seven clones budded in 1931 has shown over a period of four years that the clones differ in their response to the periodic systems; clone Tjir 16 showing the best response and AVROS 50 the poorest. The mean yield of all clones in the fourth year of tapping expressed as a percentage of the yield in the continuous system is in all periodic systems, especially in the systems of 67% intensity, greater than the tapping intensity.

In a small scale trial conducted on the same clones, to investigate the effect of extending the interval between tappings on a full spiral cut from four to five or six days, the results over a period of four years show a reduction in yield in the tapping systems of 80% and 67% relative intensity. This is not significantly different

from the reduction in tapping intensity, although in the fourth and fifth year of tapping the yield in the systems with intervals of five and six days between tapplings has been appreciably in excess of the relative tapping intensity.

A small scale trial on a mixed stand of clones Tjir 1 and Pil B84 budded in 1939-40 compared the standard system of alternate daily tapping on a half spiral cut (S/2.d/2.100%) with a system of daily tapping on a third spiral cut for about twentyfour days out of thirty (S/3.d/1.24d/30.107%), commonly used on smallholdings. Over a period of four years this has shown a small advantage in yield but a higher bark consumption in the latter system.

Results of an experiment on budded trees of mixed clones for the first three years of tapping, which compared three full spiral systems of 100% intensity with the standard system S/2.d/2.100%, show a slight advantage in yield for the full spiral fourth daily system (S/1.d/4.100%), no difference in yield of the full spiral third daily system with nine months' tapping out of twelve (S/1.d/3.9m/12.100%), and a small decrease of yield in the full spiral alternate daily system with two months' tapping followed by two months' rest (S/1.d/2.2m/4.100%).

TAPPING EXPERIMENTS ON ESTATES

A tapping experiment was designed to provide information on the effect of periodic change over of tapping panels in half spiral systems and of different periods of tapping and rest on full spiral systems. This was set up in April 1950 in an area of 38 acres of young trees of clone Tjir 1 which were budded in 1941.

There are fifteen tapping systems in the experiment and, as some of the periodic systems with 32 or 36 months of tapping before rest have not yet been rested, it is too early to comment on the results of the first two years of tapping. It is noted however that all systems have yielded in excess of their relative intensity.

Of four other tapping experiments on estates one was discontinued during the year. The three remaining experiments compare two systems of full circumference tapping with the standard system S/2.d/2.100%. The results for the first four years of tapping of one experiment, and for the first five years of tapping of the other two experiments, show that clone BD 5 is the only clone under test which has given consistently better yields in full circumference tapping, although clones PB 86 and PB 186 have given favourable responses in two of the experiments. Clone Gl 1 continues to react unfavourably to full circumference tapping.

SLAUGHTER TAPPING

A slaughter tapping experiment which included upward tapping and in which seven tapping treatments were divided into two sub-treatments, one of which was treated with a yield stimulant once every four months and the other not, was carried out on high yielding seedling trees on the Experiment Station during the year. The experiment ran for exactly one year and the results for the first six months show an increase in yield of more than 100% in the system with four half circumference cuts tapped alternate daily (2C/1.d/2.400%), and of about 60% in systems of 267% intensity with four half circumference cuts tapped third daily (2C/1.d/3.267%), two of the cuts being tapped upwards in both systems. The use of yield stimulants in conjunction with such heavy tapping systems had no appreciable effect on yield.

Fourth daily systems of 200% intensity (2C/1.d/4.200%) resulted in an increase in yield of only 20% but showed a marked response to yield stimulants which increased the yield by 75% of the pre-treatment yield. The combination of these 200% intensity systems with yield stimulants thus gave better results than systems of 267% intensity with or without yield stimulants. It would appear, therefore, that in slaughter tapping a reduction in the intensity of tapping may be compensated for by the use of yield stimulants.

IVPHYSIOLOGY

Preparations were made during the last quarter of the year to set up sand culture experiments with hevea. The physiologist engaged on nutrition work spent some time examining routine analytical methods for their suitability for work on hevea.

The deliberate interruption of possible paths of translocation of food materials or latex or both, towards the tapping cut, has been studied in a small scale experiment. Conduction is normally vertical and takes place in the thin layer of 'bark' left after tapping, but when these channels of conduction are severed by tapping to the wood, lateral translocation may take place instead. These results have been confirmed in a large scale experiment.

STIMULATION OF YIELD

An investigation of the effect of copper compounds injected into the main stem of hevea trees (10 to 12 grams per tree) on latex

yield and on the properties of the rubber was carried out during the year. Substantial yield increases have been obtained over a period of three months for copper sulphate, copper nitrate, but not for copper oleate. No differences of any importance have so far been found in the properties of the latex, or in the ageing properties of the rubber, as a result of these injections of copper salts but owing to risk of accidental copper contamination of the latex this method of yield stimulation cannot be recommended for use in general practice.

Trees which had been rested for periods varying from 2 to 24 months owing to drying up of the tapping panel were brought back into tapping; after about three successive tappings 30 trees were injected with copper sulphate and the same number were treated with a proprietary yield stimulant. Both treatments resulted in a marked increase in yield over the next four months *e.g.* a 28% increase due to copper sulphate and one of 45% due to the proprietary yield stimulant. A reduction of about 10 d.r.c. percentage units of the latex took place during the same period.

A second application of the copper sulphate and yield stimulant treatments at the end of the fourth month resulted in a yield increase of about 10 per cent and 30 per cent respectively over the next two months, after which the yields fell back to normal. The copper content of the latex of treated trees increased steadily up to the sixth month after which it showed no further increase. None of the trees had shown signs of going dry by the end of the year and, as the resumption of yield of these former 'dry' trees may have been in some measure due to rest from tapping, another experiment was carried out in which trees were injected with copper sulphate as soon as they were taken out of regular tapping owing to brown bast. In this experiment 11 of the 27 trees injected were almost dry, 6 trees were completely dry and only 4 trees yielded more than 20 grams per tapping three and a half months later when a second series of injections was carried out. Two months after the second injection 15 out of the 27 trees were completely dry and only 4 trees yielded more than 20 grams per tapping. The experiment has been discontinued. It would seem that the increase in yield of the trees which responded to the treatment was from the parts of the bark which before treatment also yielded some latex. The affected bark remained dry showing that the yield stimulants are no cure for true brown bast.

A number of experiments have been in progress during the year in continuation of the pre-war work on yield stimulation. The first experiment was carried out on seedling trees planted in 1931. These had been in regular tapping for only one and a

half years when the treatments were applied to a three inch strip of lightly scraped bark below the tapping cut. Results over a period of three and a half months showed highly significant increases in yield brought about by application of two proprietary yield stimulants (about 26%) and by a 1% emulsion of the sodium salt of 2,4-dichlorophenoxy acetic acid (2,4-D) in palm oil (23%). Bark scraping alone resulted in a 10% increase in yield.

An emulsion of 0.1% 2,4-D in palm oil gave a 15% increase in yield over the same period but all other treatments, which included 0.1% of the sodium salt of 2,4-D or 0.1% of 1 or 2 naphthoxy acetic acid or 0.1% indole butyric acid or 0.1% naphthalene acetic acid or 0.1% chlorophenoxy acetic acid, as emulsions in liquid paraffin, gave no significant increase in yield.

When the 3 inch strip of treated bark had been tapped off, the treatments were repeated on the same trees with the exception that the emulsions of 0.1% 2,4-D in liquid paraffin and in palm oil were replaced by emulsions of 2% 2,4-D in these oils. The results over a further period of three and a half months again showed highly significant yield increases by the two proprietary yield stimulants (41 and 43%) and by the 2% emulsion of the sodium salt of 2,4-D in palm oil and in liquid paraffin (37% and 29% respectively). Bark scraping alone resulted in a 13% increase in yield. The 1% emulsion of 2,4-D in palm oil gave a 29% yield increase and the 0.1% emulsion of 2-naphthoxy acetic acid in liquid paraffin caused a decrease in yield.

A third application of bark treatments to a new tapping panel of the same trees gave, over a period of three months, increases in yield of 35 to 45% by the proprietary yield stimulants and the 1 to 2% solutions of the n-butyl ester of 2,4-D in palm oil, of which 20% increase is due to the effect of scraping alone. In concentrations of 0.1% and 1% 1-naphthalene acetic acid has not increased yields in any of these trials. Good results have been obtained with p-chlorophenoxy acetic acid at 1% concentration.

In these experiments there was no significant difference between the proprietary yield stimulants and the 1% and 2% sodium salt or the n-butyl ester of 2,4-D in palm oil or liquid paraffin. The yield in none of these treatments has dropped to below the pretreatment levels and there has been no increase in brown bast incidence.

Another experiment on high yielding clonal seedlings planted in 1931 and on buddings of clone PB 186 budded in 1932 was carried out. For seedling trees, the results over three and a half months after first application of the treatments to a 3 inch strip

of lightly scraped bark below the cut show substantial yield increases of about 35% due to the two proprietary mixtures and the 1% concentration of the sodium salt of 2,4-D in palm oil. Bark scraping alone resulted in a 7% increase in yield. Injection of copper sulphate (12 grams per tree) increased the yield by 20%.

Over a period of six months after the first application of the treatments, results show a general decline in the level of yield increase, which is 26% with the proprietary mixtures and the 1% concentration of the sodium salt of 2,4-D in palm oil. With budded trees the corresponding yield increase over a period of three and a half months, due to bark treatment, was 30% of the pre treatment yields. Disappointing results were obtained over a period of four months following a second application of the same treatments, possibly due to too heavy scraping of the bark.

Trees of a clone of *Hevea spruceana* which gave the extremely low average yield of 2 grams of dry rubber at each tapping were treated with the yield stimulants which had given the best results in previous experiments. The yield was doubled over a period of three months following treatment but remained quite uneconomic.

DRY TREES

A questionnaire was sent in August 1952 to all estates on our mailing list in Malaya, Borneo, Sarawak and Brunei to inquire into reports of mature rubber areas in which trees occurring in compact blocks had ceased to give normal yields without any apparent reason. The symptoms should not be confused with those of typical brown bast which affects scattered individuals. An acreage of approximately 800 acres, representing 0.02 per cent of the total rubber acreage of Malaya in 1951, has been reported as non-productive.

The affected areas have been visited and bark samples have been found to have one feature in common, in that they show the same type of anatomical abnormality characterised by the presence in superabundance of stone cells in the phloem extending from the hard bast (not latex bearing) and penetrating nearly to the cambium. Furthermore in a high proportion of the bark samples examined an abnormally high occurrence of calcium oxalate crystals has been observed in the soft bast, especially in the upper and lower cells of the medullary rays (as seen in tangential sections).

In transverse and longitudinal sections it is observed that the latex vessels, with the exception of the two or three innermost rings, are nearly completely enclosed by sclerotic tissue and that an accumulation of starch occurs in the unaffected parenchyma

cells. The indications are that transport of nutrients is greatly impeded and that rubber formation is much restricted or even stopped altogether.

Experiments with yield stimulants have shown that although the latex yield of these trees is considerably increased, the surplus yield is obtained only from the innermost rows of latex vessels which were functional before the treatments were applied — that portion of the bark which had ceased to yield was not stimulated. This condition of the bark differs from true brown bast in that it is not restricted to the tapping panel but occurs higher up the main stem of the tree. The cause of the condition is not yet known but it has been noted that a number of these 'dry' areas are situated on heavy waterlogged soil or on badly eroded slopes, where conditions for growth are clearly unfavourable. There is no obvious cure for this bark condition and it remains to be seen whether it will be in evidence on young trees replanted in these areas. Investigations continue.

STIMULATION OF BARK RENEWAL

Experiments on the stimulation of bark renewal have been in progress during the year. Sebacic acid, thiourea and glutathione at concentrations of 0.001, 0.01, 0.1, 1.0 and 10% in water in oil emulsions have been applied to a 3 inch strip of tapped bark immediately above the tapping cut on 15 years old seedling trees. Measurements of bark thickness taken at quarterly intervals during the year have shown no significant effect of any of the treatments on the rate of bark renewal.

A small scale trial with a Chinese mixture consisting of soya bean refuse, sea mud, oven ash and other ingredients, used extensively on a Chinese estate for the stimulation of bark renewal, applied to the tapped bark to a height of 12 inches above the tapping cut, has revealed some positive response on the rate of bark renewal. It is too early to draw definite conclusions.

A third experiment on stimulation of bark renewal was set up during the last quarter of the year on 22 years old buddings of clone AVROS 50. The experiment comprises twelve treatments which have proved beneficial in promoting either the healing of wounds (*e.g.* Vacuum Product 2295-C) or in improving yield (*e.g.* *n*-butyl ester of 2,4-D in palm oil).

The increase in bark thickness will be determined by bark measurements and microscopical examination of the bark will be made in order to ascertain whether the increase in bark thickness is due to activation of the true cambium rather than that of the cork cambium (phellogen). Yields will be recorded to find out if

they are in any way influenced by the applications of the mixtures above the tapping cut.

V

ECOLQGY

An investigation of the effect of a jungle spraying trial with triox-one and sodium trichloracetate showed one month after spraying that plants under shade were less affected than those in the open. Monocotyledons were the least affected and *Gleichenia* was the only fern susceptible to the effect of the spray mixtures. Rubber trees were entirely defoliated by the spray mist accidentally blown over them during the spraying operation.

The completely affected trees include *Litsea megacarpa*, *Dillenia grandifolia*, *Litsea curtissi*, *Litsea robusta*, *Baccaurea parviflora*, *Barringtonia scortechinii*, *Koompassia* sp, *Alstonia scholaris*, *Macaranga* sp, *Santiria* sp, and *Eugenia longiflora*.

Plants which were only partially affected were *Endospermum malaccense*, *Knema* sp, *Palaquium* sp, *Sonneratia* sp, *Paropsia vareciformis* and *Eugenia* sp.

The unaffected plants which include herbs, shrubs and young trees were identified as follows: *Xerospermum intermedium*, *Dysoxylum costulatum*, *Epiprinus malayanus*, *Gomphia oblongifolia*, *Dacryodium* sp, *Knema oblongifolia*, *Xanthophyllum wrayi*, *Melanochyla kunstleri*, *Nephelium lappaceum*, *Eugenia* sp, *Diplospora malaccensis*, *Ixonanthes icosandra*, *Gonystylus maingayi*, *Homalomena sagittaeifolia*, *Alpinia* sp, *Didymosperma* sp, *Ochlandra ridleyi*, *Calamus* sp, *Piper* sp, *Phyllanthus frondosus*, *Ardisia crenata*, *Psychotria* sp, *Smilax* sp, *Sonneratia* sp, *Palaquium* sp, *Pandanus* sp, *Roucheria* sp, *Vitis* sp, *Anisophyllea* sp, *Chailletia* sp, *Pometia alnifolia*.

Some of the partially affected trees e.g. *Endospermum malaccense* and *Eugenia* sp, had been completely defoliated. Likewise a few of the trees which were found totally affected in the beginning e.g. *Alstonia scholaris*, *Dillenia reticulata*, and *Palaquium obovatum* have shown active signs of regeneration in the form of a vigorous growth of young shoots from the defoliated branches.

Changes were being studied up to the fourth month after spraying when it was found that all the trees with large leaf size had been affected either partially or completely. Climbers, monocotyledons and geophilous plants were little affected. It was also

BOTANICAL DIVISION: RESEARCH

noted that most of the unaffected smaller plants were shaded by the foliage of the bigger trees and were not in an open situation at the time of the spraying. A good example of this is provided by a group of *Ochlandra*, *Piper* and *Ardisia* growing together in a shaded grove which have not been affected in the least.

Studies of various types of shade plants in a mixed cultivation of rubber and cacao have been in progress during the year.

EXPERIMENTAL PLANTING ON ESTATES

During the year under review the acreage under experimental planting on estates was reduced from 1624.4 to 1343.5 acres comprising 36 field trials.

The decrease in the acreage is accounted for by bandit slashing of bark in three trials totalling 124.5 acres, cessation of yield recording in an area of 60 acres owing to terrorist activity in the district and the termination of two trials totalling 96.4 acres.

There were at the end of 1952 four large scale trials of the older proved clones occupying 290.4 acres and the same number of subsidiary clone trials occupying 52.3 acres. Yields have been recorded for five years in four of these trials, for four years in three trials and for three years in one trial. The clones were budded in 1938 and are tapped on the half spiral alternate daily system (S/2.d/2.100%).

Clone PB 86 remains in general the highest yielder on both inland and coastal soils, followed by clone Tjir 1. Clone Tjir 16 has yielded more than either PB 86 or Tjir 1 on one inland estate and on the same estate clone Sab 24 has given a high yield in 1952. Clone Gl 1 shows a high incidence of brown bast; the yields have either not increased or have actually decreased during the year under review.

Yields of a number of clones made from high yielding seedling trees on estates have been recorded in three of the four trials budded with these clones. The performance of none of these clones has been found to be consistently outstanding.

Yield recording in ten trials, totalling 410 acres, of clonal seedling families from seed gardens and budded areas on estates continued during the year. Yields relative to the control clone Pil B84 continue to show a downward trend and in the fifth year of tapping the yield of many of the seedling families is not appreciably higher than that of the Pil B84 buddings. Tjir 1 selfed seedlings and P.B.I.G. mixed seedlings from gardens C, D and E have given the best performance and are of about equal merit.

Brown bast incidence in the seedling families is high in some trials and is on the average more than twice that recorded in the

trials of RRIM '500' series clones in the same areas. Brown bast records for the fourth year of tapping show that the incidence is higher in P.B.I.G. seedlings than in Tjir 1 selfed seedlings in four out of five trials from which records are available.

As a means of combating brown bast the S/2.d/2.100% tapping system in one trial has been changed to a change over system, represented by the notation S/2.d/2.(2 × Y/2).100% (in which half spiral cuts on opposite sides of the tree are tapped alternately for a year and rested for a year) and in another trial to half spiral alternate daily periodic system (S/2.d/2.6m/9.67%).

Yield recording was continued during the year in 14 trials totalling 427 acres of the RRIM '500' series clones. Clones RRIM 501 and 513 — outstanding in these trials — continue to yield well, with RRIM 501 the higher yielder on four estates out of five. Clone RRIM 519 has equalled the yield performance of clone RRIM 501 in three trials but is rather susceptible to brown bast.

It is interesting to note in this connection that, in the large scale trials RRIM '500' series clones on the Experiment Station, the yield of clones RRIM 501 and 513 relative to the control clone were approximately the same in 1952; clone RRIM 519 on S/3.d/2.67% tapping yielded 84% of the yield of clone RRIM 513 on S/2.d/2.100% tapping in the same section of the trial.

Clones RRIM 526 and 527, especially the latter, continue to do well in the large scale trials on the Experiment Station. Two small scale trials of proprietary clones on estates have continued in recording, in the first trial on a coastal estate clones PB 5/37 and 6/57 have been outstanding yielders during 1952 and in the second trial on an inland estate clone Ward A9 has outyielded the PB clones 5/51, 5/60 and 5/37 — these four clones being the best yielders in the trial.

Three experiments on stock and scion relationships were originally established on estates but yields have been recorded in only one of the experiments, which occupies an area of 28 acres on an estate situated on coastal alluvial soil. In this experiment the yields of clone Tjir 1 over a period of three years have been shown to be significantly greater when budded on to seedlings of clone Tjir 1 than on to seedlings of clones SR 9, BD 10, Pil B84 or unselected seedlings. No marked differences are revealed between the other stocks and no other clone has done better on its related stock.

In the method of planting experiment (56 acres), which compares the performance of the same clones budded in the field onto seedlings planted as germinated seed at stake or as seedling stumps and budded in the nursery and transplanted to the field as

budded stumps or stumped buddings, the early advantage of the nursery prepared material has not been maintained and the results of the fourth year of tapping show no significant difference between any of the methods of planting.

A density of planting experiment (80 acres) on one estate continues in recording. The results will be given in a subsequent report.

The performance of clones and clonal seedling families in large scale experimental plantings established on the Experiment Station and on estates between the years 1937 and 1940 has been under regular observation and the yield and growth data are being summarised for publication in the *Journal of the R.R.I. of Malaya*.

We take this opportunity of placing on record our indebtedness to the estate managers and their field staff for their active and helpful cooperation under difficult conditions, which has enabled us to obtain valuable records from these field experiments.

ADVISORY

DURING 1952 AN APPRECIABLE increase of letters received in the Division brought to a halt the progressive decrease experienced since 1949, which reached lowest level during 1951 when presumably terrorist activity was at its peak.

The trend of advisory activities during these years is shown in the following analysis.

	1949	1950	1951	1952
Inquiries received	1,366	1,093	924	1,484
Visitors to Division	76	79	48	89
Visits to Estates	55	73	21	49
Samples received for examination or identification	46	27	21	76

Correspondence connected with experimental planting on estates (663 letters received) has been excluded from these records.

In the review which follows the advisory correspondence has been analysed separately under the major sections of the research programme as this may provide a better picture of the commonest subjects of inquiry. Some 1100 advisory letters were despatched in reply to inquiries which could not be dealt with by printed circulars or advisory leaflets. The telephone is still used to a large extent for inquiries of an urgent nature and also for routine advice which when given verbally usually required confirmation by letter.

BREEDING AND SELECTION

Fiftyone inquiries received in 1952 were concerned mostly with the establishment of seed gardens and with the selection of areas for collection of clonal seed.

The wide interest abroad in high quality clonal seed for use as planting material led to the preparation of an article for *Planters' Bulletin*, describing the layout of seed gardens, with information regarding the selection of clones known to be good seed parents and their disposition along the rows to give the maximum opportunity for all the possible crosses to occur. A new list of suppliers of clonal seed was prepared as Advisory Leaflet B/AL.27 (52).

Sixtythree rubber seed samples were received from estates for identification.

PROPAGATION AND PLANTING TECHNIQUE

The greatest number of inquiries have been on the choice of planting material. These have been analysed separately from routine replanting inquiries, which include hedge planting and methods of clearing old rubber by tree poisoning.

1952

Choice of planting material (clones and clonal seedlings)	366
Replanting inquiries	47
Tree poisoning	12

The following Circulars were prepared for publication in 1952:

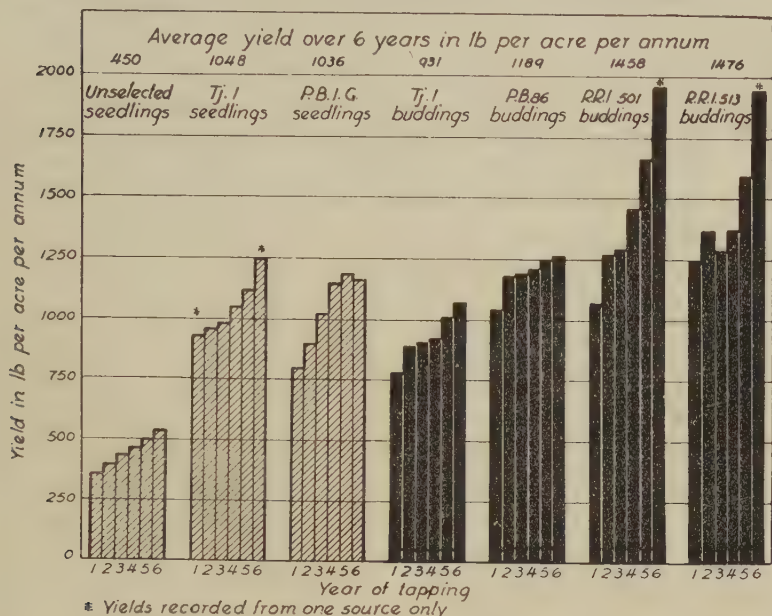
Note on Clone LCB 1320 (Circular 34)

Choice of Clones and Clonal Seedlings: Planting recommendations for 1952-3 (Circular 37)

Yield data of planting material recommended for use on a large scale in Malaya, recorded in commercial plantings tapped on the standard system alternate daily on a half spiral cut (S/2.d/2. 100%) are presented in the histogram. These records show a remarkably close agreement with the data obtained from statistically designed experimental trials on estates. At least for the first six years of tapping, clone PB 86 gives slightly better returns than the best of the seedling families (P.B.I.G. seed from gardens C, D and E and Tjir 1 selfed seed) which in turn yield more than buddings of clone Tjir 1 while the clones RRIM 501 and 513 give the highest yields of all. The latter were recommended for large scale planting on the evidence of their performance in experimental plantings on estates.

BOTANICAL DIVISION: ADVISORY

Twentyfive requests were received from estates for the identification of nursery and, to a lesser extent, field buddings.



TAPPING

Inquiries mainly concerned tapping systems, standard of 'tappability', bark consumption, bark renewal, test tapping and slaughter tapping. They numbered 49, and 136 letters were received on the subject of yields of buddings and clonal seedlings in commercial tapping. An article entitled 'A Comparison between Alternate-Daily A.B.C. (Periodic) and Third-Daily Tapping Systems' was published in *Planters' Bulletin* 1.

In our oldest experiments on full circumference tapping the yields during the period 1935 to 1952 of seedling trees on the double four and the full spiral fourth daily systems have been ten per cent higher than on the half spiral alternate daily system. On budded trees the double four system has resulted in a loss (relative to the half spiral alternate daily system) for all clones except AVROS 50; the average loss over the full period of tapping, from 1937 to 1952, being about 23% with a loss of girth of nearly four inches. Our tapping experiments on the Experiment Station and estates have shown that clone Gl 1 is particularly ill suited to full circumference tapping as regard yield and brown bast incidence.

In slaughter tapping it would appear that a reduction of tapping intensity may be compensated for by the use of yield stimulants.

PHYSIOLOGY

Thirty inquiries on yield stimulation were received during the year, the revived interest in the subject resulting from the publication of papers read at the Latex Symposium held at this institute in February 1951.

The yield stimulating effect of copper sulphate injected into trees has been confirmed. No differences of importance have been found in the properties of the latex or in the ageing properties of the rubber from injected trees have so far been found but owing to the extensive damage which may be caused to the trees and the serious risk of accidental contamination of the latex, the method cannot be recommended for general use on estates. Our experiments with yield stimulants applied to a strip of bark below the tapping cut have shown no harmful effects on yield or brown bast incidence of four successive treatments with intervals of six months between treatments. The affected bark in brown bast trees treated with yield stimulants remains dry showing that yield stimulants are no cure for brown bast. The normal butyl ester of 2,4-D at 1% and 2% concentrations in palm oil has been shown to compare favourably as a yield stimulant with the commercial preparations on the market, and to be superior in that respect to copper sulphate injected into the tree.

ECOLOGY

Routine work under this section consisted in the identification of indigenous cover plants received from estates. Twentyfour plant specimens were identified for estates and eightyfour mounted herbarium specimens were named for the technical department of a rubber company.

Sixteen germination tests were carried out on commercial seed samples of leguminous cover plants.

A note on the leguminous bush cover plant *Flemingia congesta* was prepared for publication in *Planters Bulletin*.

GENERAL PLANTING INQUIRIES

There were ninetythree inquiries of a general nature during the year, the commonest concerning planting distances for budded and seedling trees, methods of planting, and rate of growth in replanted areas.

Visits to estates were necessarily curtailed owing to the absence on leave for seven months of the Head of Division. Of the 110 visits made 49 were of a general advisory nature. Thirtyfive

BOTANICAL DIVISION: ADVISORY

estates in Malaya and twelve estates in North Borneo were visited by a member of the junior staff of the Division for purposes of clone identification.

Eightynine individual visitors called during the year and sought advice, mainly on choice of planting material and on tapping. Visitors to the Experiment Station to view and discuss the work of a botanical nature totalled fortynine. A number of these visits were made in company of a research officer.

E.D.C. BAPTIST

Head of Botanical Division

PATHOLOGICAL DIVISION

THE YEAR WAS ONE OF BROKEN SERVICE by the senior staff. Mr R.A. Altson, who joined the Institute as Head of the Division in 1946, left on retirement in September. In him the Division lost a greatly respected chief, under whose guidance the Division had been re-established on a sound foundation. Dr A. Newsam, the Entomologist, who had returned from long leave in January, was appointed in his place. The Field Research Officer, Mr F.W. Hutchison, left for the U.K. in August having deferred his leave to enable him to carry through our first aerial spraying trials. Mr R.N. Hilton, the Pathologist, completed his investigation on bird's eye spot disease and saw his paper through the press before departing on leave in November. Mr K.P. John left in July for his leave in India, returning early to duty in November, to be back soon after Mr Hilton's departure. The Research Staff was strengthened by the appointment of Mr B. Sripathy Rao, B.Sc.(Hons) Madras, who assumed duty as Assistant Entomologist in June.

The conference of Rubber Research Institutes in the Far East which took place at Bogor in July was attended by Messrs Hilton and Newsam, who presented papers prepared by themselves and Mr Hutchison.

Contributions to the *Journal of the Rubber Research Institute of Malaya* were 'A Hitherto Undescribed Leaf Disease of Hevea Rubber caused by a Species of *Colletotrichum*' (Communication 278) by Mr K.P. John and 'Bird's Eye Spot Leaf Disease of the Hevea Rubber Tree caused by *Helminthosporium Heveae* Petch' (Communication 280) by Mr R.N. Hilton. Articles were prepared for the third issue of *Planters' Bulletin* devoted entirely to pathological subjects.

Air-conditioned glasshouse — An air-conditioned glasshouse was completed by September. It has two rooms, each 12ft by 8ft and served by a water cooled Autoclima 400 Continental Model. After initial troubles, the units continued to function correctly, but operating conditions in the house have not been entirely satisfactory. The relative humidity is fairly constant at about 90 per cent during the night but when the units are switched on in the morning it quickly falls to about 70 per cent and carries on falling irregularly to about 50 per cent at midday, after which it rises irregularly.

Although conditions in the house are not the same as outside, rubber seedlings are growing well in it. On them we are rearing mites and mealy bugs in single infestations to observe their effect on the plants. We plan also to use the house for inoculation experiments with root diseases. There is a further possibility that

we may employ it for plant quarantine; for this a device would be needed to extract particles as small as a fungal spore from the outgoing air.

Acknowledgements — We are indebted to the Agricultural Sub-Committee of the London Advisory Committee for Rubber Research for advice on our research programme; to the Commonwealth Mycological Institute and the Department of Agriculture, Federation of Malaya, for assistance in a variety of ways. For the identification of many insect specimens we are indebted to the Commonwealth Institute of Entomology; for identifications of mites to Dr O. Evans of the British Museum, and of molluscs to Dr R.T. Abbott of the U.S. National Museum.

Our aerial spraying project has been greatly helped by many persons and organisations. We would particularly mention Prof G.E. Blackman of Oxford University; the Chemical Defence Experimental Establishment, Porton; the Department of Civil Aviation, Malaya; Messrs J. Hasson and C.F. Isherwood of the Telecommunications Department. Lastly, we would gratefully acknowledge the important part played by two officers of the Federation Air Service — Mr F.J. Anderson, the Engineer-in-Charge, and Capt. P.R. Gaskell, the Senior Pilot, who flew the plane.

RESEARCH

I

DISEASES OF THE ROOT SYSTEM

Three replanting field experiments were in progress during the year. These investigations are of necessity long term, since whatever is being tested must be judged ultimately by root disease incidence and losses therefrom over at least the first six years of the life of the young stand, when the bulk of the trouble occurs. It is therefore greatly regretted that one of the three experiments, the first to be put down after the war, had to be abandoned. Established on Pataling Estate in 1948, it was swallowed up in the area allocated to the development of a new village.

The experimental area on Pataling Estate (P 48) was hedge planted 50 ft by 3 ft. The experimental treatments consisted of two methods of control compared with no control measures. In both

the control methods the sources of infection (mostly old stumps) were removed and burned, but the method of detecting infection in the young stand differed. In the *A* plots rounds of tree to tree collar inspection were carried out; in the *B* plots the disease was recognised by the appearance of the foliage. By the time the leaves have started to wilt the collar of the tree is already quite dead and the tree beyond saving. In the *B* plots, therefore, treatment consisted in removing diseased trees and from them tracing out and eradicating the source of infection. In the *A* plots the position was different only in that by collar inspection it is possible to detect and treat an attacked tree before the damage is irreparable. Although four rounds of inspection and treatment were carried out in the first three years, only three trees were saved — a somewhat surprising result perhaps partly to be explained as the trees were in hedges in which the disease had only a short distance to move from one to another. The overall incidence of disease was low, eight cases per acre in four years, equivalent to four per cent of the original stand. *Fomes lignosus* as usual was the predominant disease at first, but by the time of the last inspection the *Ganoderma* cases were slightly more numerous.

Of the other root disease field experiments little need be said. That laid down on Galloway Estate in 1950 (G 50) was a comparison of pre-planting treatments of the stumps of the felled stand. Isolation trenches which are necessary to prevent interference of one treatment with its neighbour were dug round the experiment plots. The first round of inspection and treatment was completed.

The large experiment laid down on Carey Island in 1951 (CI 51) includes pre-planting as well as post-planting treatments. All that was called for in 1952 was an examination of stumps to compare the death rates following different procedures. Counts made twelve months after treatment were limited to lateral roots which are in practice far more important than the bole, since root contact is much more commonly made with them. About 75 per cent of the laterals were alive on stumps where no poison had been used. More than half of the balance had been killed by root disease. Two stump poisoning procedures (the ringbarking and fissure methods) gave about 25 per cent laterals alive, while the same methods applied to standing trees had killed more than 90 per cent of the roots. The auger method of stump poisoning had killed all but 1 per cent. The three results which can be compared between G 50 and CI 51 agree reasonably well and also accord

with the views expressed in our Circular No. 36,* where it is stated that an auger method is the most efficient way of poisoning a stump but considerations of cost preclude its general use on estates. Ringbarking has been preferred although not quite so effective; now the possibility emerges that the fissure method may be the best.

While the field experiments are of direct practical consequence, another and more fundamental approach is being made to the problem through observations on soil organisms which are antagonistic to the root disease fungi. By making extracts of cultures of the fungi under test and incorporating them in a culture medium for *F. lignosus* and other root disease fungi it has been demonstrated that *Trichoderma viride* and a species of *Penicillium* show marked antibiotic production. Results with *Botryodiplodia theobromae* were inconclusive. The last named is a natural choice for the investigation because it is invariably present in decaying wood, being the cause of the familiar black discolouration.

As an extension of the idea behind these investigations, a start has been made in preparing nursery beds with different soil treatments designed to modify the soil microflora, then to measure the rate of spread of one of the root diseases in the different soils. Counts which have been made to estimate soil fungi in samples from the different plots already indicate two interesting things. Firstly, the best represented groups are those which produce antibiotic substances; secondly, the cultivation of legume creepers in one case at least markedly changed the composition of the microflora, decreasing the abundance of *T. viride* and increasing that of a species of *Aspergillus*.

In conclusion it may be mentioned that observations have been continued on the viability of the root parasites in buried fragments of diseased root. Results to the end of the second year have been published in our annual *Report* for 1951. It is striking how long the three parasites survive in quite small pieces of root. It should be borne in mind in this connection that the observations were made in soil which was kept clean weeded; it is possible that in soils rich in humus the rate of decay and loss of infectivity would be faster. Further, as is shown by the table on page 6 of the last report, the chance of a diseased root fragment inducing infection falls off rapidly with reduced size.

* Circular 36 is superceded by *Planters' Bulletin* 10.

II

DISEASES OF THE TAPPING PANEL

MOULDY ROT

An investigation into the tar oil fungicides used for the control of mouldy rot was initiated at the University of Bristol Research Station, Long Ashton, at the instigation of the R.R.I. and with the agreement of the Agricultural Research Council. The principal aim is to determine the active ingredients, with a view to developing an improved product. Also, when more is known about the composition of the tar oil fungicides it may be possible to prepare a specification with which proprietary materials must comply if they are to receive official approval.

Late in the year three emulsified tar fractions were received from Long Ashton and subjected to field trials after they had successfully passed preliminary bark burning tests. The phenolic fraction gave results comparable with those of a good approved fungicide; the neutral tar oil fraction, on the other hand, was markedly inferior. The field results in Malaya and those obtained in the laboratory at Long Ashton showed good agreement. The investigations are proceeding.

At the same time new synthetic fungicides are being tried against the mouldy rot fungus. An organo-mercurial and four cationic detergents have been subjected to preliminary laboratory and bark burning tests which indicate the phytotoxic limit to be 1 per cent or higher, while the fungicidal level was only 1/100 as much for the detergents and 1/20 for the mercurial. Field tests have yet to be carried out.

A proprietary tar oil emulsion submitted for test with a view to its inclusion in the list of materials officially approved for the control of mouldy rot was found to be satisfactory at a concentration of 5%.

III

SECONDARY LEAF FALL

The course of the disease was followed from observations made on specimens received in response to the annual circular which has been issued from 1948 onwards. Reports were generally of slight to moderately severe outbreaks. None was received from either Kelantan or Trengganu.

PATHOLOGICAL DIVISION: RESEARCH

DISTRIBUTION OF KNOWN OUTBREAKS OF SECONDARY LEAF FALL

Territory	Outbreaks				Totals
	Mar.	Apr.	May	Jun.	
<i>Kedah</i>	8	3	2	—	13
<i>Penang & P.W.</i>	1	—	—	—	1
<i>Perak</i>	16	15	2	—	33
<i>Selangor</i>	1	14	1	—	16
<i>N. Sembilan</i>	2	5	1	—	8
<i>Malacca</i>	1	—	1	—	2
<i>Johore</i>	1	1	—	—	2
<i>Singapore</i>	—	—	—	1	1
<i>Pahang</i>	—	—	1	—	1
<i>Totals</i>	30	38	8	1	77

Examination of a total of 219 specimens showed that the season had been exceptionally favourable for *Gloeosporium* and thrips, both of which appeared more frequently than is usual; *Oidium* on the other hand was so much less prominent that it became doubtful whether it held its usual place as the parasite contributing most to secondary leaf fall. The outbreak recorded from Pahang was an extreme case; of the 50 specimens sent in only 4 were attacked by *Oidium* whereas 49 were attacked by *Gloeosporium*, mites and thrips being recorded on 32 and 22 respectively. These figures have been omitted from the table below for the country as a whole as they would unduly bias the results.

INCIDENCE OF THE PARASITES ASSOCIATED WITH CASES OF SECONDARY LEAF FALL

Parasite	Percentage of cases in which	
	present	unassociated
<i>Oidium heveae</i>	76	4.7
<i>Hemitarsonemus latus</i>	83	1.2
<i>Gloeosporium alborubrum</i>	54	4.1
<i>Scirtothrips dorsalis</i>	50	nil

A second wintering period is usual in the south of the country, followed by a late secondary leaf fall. Five reports of such outbreaks were received during August and September, one from Negri Sembilan, three from Johore and one from Singapore Island. All were predominantly due to *Gloeosporium alborubrum*.

IV

OTHER LEAF DISEASES

Following on the finding made in 1950 that sulphur is useless against *Gloeosporium alborubrum*, tests carried out in the laboratory have shown two proprietary dusts — Vitospor ZX and Vitospor FX — to be effective against the fungus. Applications of the former are being made twice a week to clone BD 5 by a power driven machine directed to one tree so that it receives a very heavy application while the surrounding eight receive the drift. The central tree and certain of its neighbours are now carrying a good crown, but it is too early to conclude that dusting, by controlling *Gloeosporium*, has prevented the defoliation which many years ago ruled out BD 5 as a clone for large scale planting.

To see whether there were any clonal differences in susceptibility to the related fungi *Gloeosporium alborubrum* and *Colletotrichum ficus*, twentyone clones were artificially inoculated by spraying the leaves with spore suspensions. At first there were many failures to infect with *G. alborubrum*, but better results were obtained when sprayed leaves were immediately enclosed in alkathene bags; under these conditions there were no indications of clonal resistance to the disease. Results with *C. ficus* were variable, five clones remaining uninfected; it would be premature, however, to regard this as proving resistance.

V

PROTECTION AGAINST SOUTH AMERICAN LEAF BLIGHT

Storage of budslips — An investigation was started in collaboration with the Botanical Division to see whether budslips could be maintained in a viable condition long enough for clonal material to be transported in this form, thereby reducing the risk of introducing diseases or pests and effecting a saving in air freight charges. Results were disappointing in a preliminary experiment in which they were treated with various fungicides and stored in previously sterilised plugged or corked tubes. No successful budding was made even with slips which looked healthy twenty days after cutting. Later an attempt was made to cut and keep the budslips under sterile conditions, but this too failed.

Aerial spraying trials — The year saw the first aerial spraying trials in the programme aimed at developing a method of eradication to be followed in event of an outbreak of South American Leaf Blight being discovered. Preliminary preparation included the construction of a piece of apparatus for the estimation of droplet sizes, following a procedure outlined by the Chemical Defence Experimental Establishment (C.D.E.E.) at Porton. In addition, observations were made on the use of hydrogen filled balloons, Verey signals and smoke generators as markers for spray runs.

The spraying trials were carried out with a de Havilland Beaver aircraft chartered from the Federation Air Service, fitted with standard Beaver spray gear purchased from the de Havilland Company of Canada. It was also necessary to purchase radio communication and other ancillary equipment. The first part of the programme, carried out at Port Swettenham airstrip with the permission of the Director of Civil Aviation, consisted of calibration flights employing a procedure developed by the C.D.E.E. From the data obtained it was possible to make calculations of drop spectrum, swathe width and rate of deposit. In the second part of the programme an area of old rubber scheduled for replanting was sprayed with a range of concentrations of the defoliant selected from earlier tests in nurseries, namely, the n-butyl ester of 2,4,5-T dissolved in Diesoline with 0.01 per cent of pentachlorophenol added to confer fungicidal activity. Concentrations above 2 per cent applied at the low rate of one gallon per acre brought about almost complete defoliation, which was only slowly followed by refoiliation. A concentration of 5 per cent of the ester was about optimal.

VII

INJURIES OF NON-PARASITIC ORIGIN

WOUND TREATMENTS

During 1951 when bandits slashed 1200 trees on the Experiment Station an opportunity was provided for comparing wound treatments. The superiority of certain greases was reported last year. This has been followed up by a small test to see whether the performance of Standard Vacuum product 2295-C could be improved by the addition of the growth promoting substances 2,4-D and 2,4,5-T. The former was taken as the sodium salt, the latter as

the n-butyl ester. Wounds of standard size were made on seedlings three and a half years old, there being two treated and two untreated wounds at the same level on each tree. Four concentrations ranging from 0.1 to 1.0 per cent were chosen, each applied to four trees; in addition, the grease alone was applied to two trees. The effect of the various treatments was compared after six months. No beneficial effect could be detected when the hormones were incorporated, but it was clear that recovery was much better under all grease treatments than in the absence of a dressing. It is thought that the action of the grease is purely physical, probably the conservation of moisture.

VIII

TERMITES

Association of termites with root disease — Observations over many years have provided abundant evidence that termites are able to attack healthy trees, but it has not been shown to what extent root disease predisposes trees to termite attack. The Experiment Station is suitable for our inquiry of this nature in that detailed records are kept of routine rounds of root disease and termite control. Since 1950 the records have been supplemented by the examination of trees lost in storms; for certain fields of mature rubber the data relating to incidence and losses due to root disease and termites are particularly complete. Analysis of the figures for 1950-1 has shown that termites alone destroyed roughly twice as many trees as were lost through root disease. The incidence of termites on diseased trees was about three times that on healthy trees; further, losses among diseased trees were increased threefold when termites were present also. None of these observations is surprising, but it is of value to have quantitative data bearing on the question.

Routine control measures for termites in mature rubber — Last year's Report gave the reasons for discontinuing chemical treatment in one of the three 40 acre fields on the Experiment Station where control measures have been under comparison. After eighteen months with no treatment beyond brushing down the mud-work as it appeared on the trunk there was found to have been a marked rise in the percentages of attacked trees re-attacked and removed. Meanwhile the two chemical treatments — the liquid method using 1 per cent mercuric chloride and the trial injection

method using white arsenic — were found to differ little in effectiveness. Since it appears that the poisons are acting in effect as repellents, without destroying the pest, purely repellent substances which may achieve the same result more cheaply are being sought.

Protection of newly planted stumps against termites — Further attempts have been made to find a method of protecting newly planted stumps against termite attack, to which they are more liable than seedlings. None has given positive results. The materials tested included two organic phosphorus compounds, parathion and schradan. The former was watered into the soil along the planting rows at the rate of one gallon of a 0.4 per cent solution to 20 square yards. Schradan, a systemic insecticide, was sprayed on to the leaves of nursery seedlings a month before they were cut back for transplanting. The failure with schradan led to an investigation of its absorption, distribution and loss in young rubber plants. It has been found that uptake is satisfactory but the amount of the poison present in the roots is negligible even when application is through the soil. The same result has been obtained by other workers using different test plants. Thus while the investigation is purely academic as far as termite control goes, there may be an application for schradan against a leaf sucking pest.

Late in the year another experiment was put down on the Experiment Station with a wider range of insecticides including aldrin, dieldrin and chlordane. The formulations employed included dusts, wettable powders, aqueous solutions and emulsions applied round the roots at planting time.

X

MITES

Red spider mites — Additional material of one of the *Paratetranychus* species found on rubber has been identified by the British Museum as *P. citri* McGregor. *P. hawaiiensis* McGregor had earlier been recognised. This leaves one species unidentified.

Coccinellid (ladybird beetle) predators found attacking red spider mites on nursery seedlings have been identified by the Commonwealth Institute of Entomology as *Stethorus siphonulus* Kapur. Two specimens collected as larvae were reared on one of the *Paratetranychus* species found on rubber.

Identification by the Commonwealth Institute of Entomology (C.I.E.) of a considerable number of insects mostly from the Experiment Station has provided the nucleus of a useful reference collection of the insect fauna of a rubber estate.

Hymenopterous parasite of the black scale — Although *Saissetia nigra* is frequently encountered as a pest of rubber seedlings it is unusual to find it parasitised. It is therefore interesting to record that three Chalcidoid parasites emerged from scales collected from a seedling nursery in the Institute compound. They have been identified by the C.I.E. as *Anysis saissetiae* Ashm. (Pteromalidae), *Microterys flavus* How. and *Cheiloneurus sp* (Encyrtidae).

Malformations associated with Coccids — *Planococcus* (= *Pseudococcus*) *citri* and *Ferrisia virgata* have been suspected of being the cause of certain malformations of young rubber. *P. citri* from rubber shoots and from cocoa are being reared on potted seedlings in an attempt to reproduce the abnormality which they are thought to cause. Five plants have produced leaves with wavy or folded margins and some leaves have leaflets of unequal size, but the characteristic malformations have not appeared. Two seedlings which became heavily infested with *F. virgata* while growing in a plant house were later observed to have produced leaves with the petioles united along their whole length. One plant had a 'leaf' with six leaflets, another had one with nine.

Newly recognised minor pests — A large number of puparia of an Aleurodid were collected from the underside of mature leaves in a nursery in the Institute compound. There was no apparent leaf damage. A few adults were bred out and the species identified by the C.I.E. as *Aleurocanthus spiniferus* Quaint. In the same nursery several trees were infested with a thrips that the C.I.E. confirmed as being *Heliothrips haemorrhoidalis* Bouche, hitherto unrecorded on rubber. When confined for observation on the lower surface of mature leaves its feeding punctures gave rise to white or light brown patches. A caterpillar found feeding on tender young leaves on the Experiment Station was reared and identified as *Adoxophyes privatana* Wlk., a Tortricid. In common with the others it is not supposed that this will ever be of economic importance.

ADVISORY

THE ASSISTANCE RENDERED by the Smallholders' Advisory Service, in that Rubber Instructors have made monthly pathological reports, has been brought to an end by their preoccupation with replanting schemes. By showing the numbers of smallholdings attacked, and the totals visited, the returns gave a useful indication of the relative importance and trends in incidence of diseases and pests. Figures have been quoted from time to time in our *Reports*; it is now appropriate to summarise the data for the five years that the return was in operation. The percentages of holdings reported as attacked by the three most important diseases and by termites are shown below. Mouldy rot is consistently the most widespread trouble, its incidence exceeding that of the other three combined.

	1948	1949	1950	1951	1952
Mouldy rot	12.5	10.6	8.4	7.7	6.6
Root diseases	5.0	3.8	3.0	2.6	2.9
Pink disease	1.3	0.7	0.4	0.3	0.4
Termites	2.3	1.5	1.3	1.0	1.1

ROOT DISEASES

Inquiries from estates were mostly concerned with the control of root disease in young rubber and were therefore largely dealt with by issue of the advisory leaflet which has since been published in *Planters' Bulletin* 4 in the new series. There seems to be an increasing awareness of the need for control measures, arising from an appreciation of the losses that can be sustained through neglect. Our standard advice continues to be basically the detection of disease by regular rounds of inspection followed by eradication of sources of infection. From the results obtained in Experiment P 48, described on an earlier page, the utility of routine collar inspections may be doubted. It may be more economical to detect the presence of disease by the appearance of the foliage. This requires investigation in other areas.

DISEASES OF THE TAPPING PANEL

All inquiries concerned mouldy rot. The effectiveness of the proved materials when used after every tapping has been constantly reiterated; reported failures are attributed to inability to make a sufficiently determined attack on the disease. Our recommendations were set out in an advisory leaflet which has since appeared in *Planters' Bulletin* 6.

R. R. I. REPORT 'FIFTYTWO

LEAF DISEASES

Secondary leaf fall has not been severe enough to lead to any demand for control measures. Observations on specimens received in response to the annually distributed circular are recorded on page 63.

Inquiries about other leaf diseases all concerned bird's eye spot disease, mostly in nurseries. Field plantings are generally less severely affected. Our leaflet on the subject does not hold out much hope of success with fungicides, to which *Helminthosporium heveae* is remarkably resistant. It is fortunate that the plants grow out of the disease in a year or two.

STEM AND BRANCH DISEASES

Pink disease was the chief concern under this heading. Advisory correspondence indicated that clone RRIM 501 may be particularly susceptible to the disease.

INJURIES OF NON-PARASITIC ORIGIN

The year produced the usual crop of miscellaneous injuries not caused by diseases or pests. On five estates lightning was the suspected cause; four estates recorded bandit slashing for which the grease dressings referred to in last year's report are so valuable. There were three cases of fire damage. Among eight other inquiries there was one case of accidental arsenic poisoning through sodium arsenite spray falling on to the trunk, and one where leaves were poisoned by arsenical fumes from the processing of ore on a nearby tin mine.

PESTS

Termites — We have continued to recommend mercuric chloride for the treatment of termites largely on grounds of simplicity and safety in use. It now appears from the results of the experiments reported that white arsenic may be a better choice, for mature areas at least, where bark burning is less of a danger and economy of more consequence than in young rubber.

Cockchafers — Three estates reported cockchafer outbreaks in the latter part of the year. Two cases were similar in that the pest — *Holotrichia* (= *Lachnosterna*) *bidentata* — destroyed many acres of legume creepers and in one area the young rubber also was being attacked by the grubs. On the third estate some hundreds of basket seedlings were destroyed by *Psilopholis vestita* in a replanting close to jungle. The attack soon passed off because the grubs were nearly fully fed by the time the area was planted.

Mites — Two reports of the withering of leaves in nurseries were found to be due to heavy attack by the yellow tea mite.

Other insect pests — Six of the inquiries involving minor insect pests were about Coccids (mealy bugs and scale insects). The three commonest species — *Ferrisia virgata*, *Saissetia nigra* and *Pulvinaria maxima* — were all represented. Coccids normally are controlled by natural agencies, but, where they become locally so numerous as to call for control measures, we recommend weekly applications of an oil emulsion spray. Five estates sent in beetles of various kinds. Only one of them, the leaf eating weevil *Hypomeces squamosus*, is capable of injuring healthy plants; the others were secondary to lightning or some other damage. Three inquiries involved ants. In two cases their presence was a nuisance only, but in the third they were boring into the stems of young trees planted in 1949 and budded in 1950. No such injury has been brought to our notice before. The ants were identified by the C.I.E. as *Sima (Sima) rufonigra* Jerd. It was found that they were breeding in large numbers in the stump of a poisoned jungle tree, whence they issued to attack the young rubber nearby.

Other animal pests — There has been a strange outbreak of bark injury of a most characteristic kind, a strip about a quarter of an inch wide being removed frequently in a flat spiral extending partly round the stem. The attacks reported from five scattered estates have all been on healthy trees two to four years old. A note on the subject was published in *Planters' Bulletin* 3. Despite the fact that a similar injury illustrated in A. Sharples' book 'Diseases and Pests of the Rubber Tree' is attributed to squirrels, recent evidence points to woodpeckers

Seven inquiries involved pigs, against which we can in the present circumstances recommend only fencing and poisoning. For the latter purpose we follow recommendations made by the Department of Agriculture. Other animals suspected of being responsible for damage of various kinds were porcupines, rats, squirrels, monkeys, deer and goats.

Outbreaks of slugs or snails were reported on five estates. On one the damage extended over most of 1300 acres of replantings. Meta-bran baits, which are very effective, succeeded in disposing of the attack even on this scale. The slugs involved were identified by the Smithsonian Institution (U.S. National Museum) as *Mariaella dussumieri* Gray and *Parmarion martensi* Simroth, the former greatly outnumbering the latter: a third species, probably *Atopos laidlawi* Collinge, was present also.

R.R.I. REPORT 'FIFTYTWO

DISTRIBUTION OF ROOT NODULE BACTERIA

Seven hundred and seventy tubes of *Rhizobium* culture were distributed to fortythree estates for the inoculation of legume cover crop seed.

SUMMARY OF ADVISORY WORK AND CORRESPONDENCE

Letters despatched	990
Specimens examined	351
Visits	110
Interviews	89

A. NEWSAM

Head of Pathological Division

CHEMICAL DIVISION

THE GRADUATE STAFF OF THE DIVISION at the commencement of 1952 comprised Mr W.G. Wren (Head of Division, appointed January), Mr G.W. Drake (returned from leave February), Mr A. Walker (resigned January), Dr R.H. Smith, Mr A.S. Cook, Mr H. M. Edmondson, Mr R.S. Gale, Mr K.C. Sekar, Mr Cheah Sein Liat and Mr B.C. Sekhar. Recruitments during the year were Mr L.L. Best, Rubber Technologist (March), Mr J.E. Morris, Analytical Chemist (June) and Dr W.A. Southorn, Chemist (November).

Staff seconded from the British Rubber Producers' Research Association (B.R.P.R.A.) included Dr A.I. MacMullen and Mr R.I. Wood, who returned to the U.K. in January and April respectively; a further secondment from B.R.P.R.A. was of Dr R. Freeman in April, for a period of three years. Dr G.F. Bloomfield of the B.R.P.R.A. spent the months of May and June working in the laboratories of the R.R.I., and Mr E.P.B. Edwards of Rubber Technical Developments worked at Sungei Buloh on pilot plant trials from September to December.

Mr K.C. Sekar went on home leave in January and returned in June; Mr A.S. Cook left Malaya on home leave during June and Mr W.G. Wren in December; Mr G.W. Drake was appointed to act as Head of the Division during Mr Wren's absence.

The Division continued to act as liaison between the Committee of Malayan Latex Technologists and the British Standards Institution Sub-Committee RUC/10/7 dealing with latex testing methods. Liaison has also been maintained with Sub-Committee XII of the American Society for Testing Materials Committee D 11, which deals with raw rubber.

The Head of Division and two members of the staff attended the Conference of the Rubber Research Institutes in the Far East held at Bogor, Indonesia, during July; papers were contributed by R.I. Wood on 'Mooney Viscosity Changes in Freshly Prepared Raw Natural Rubber', by R.H. Smith on 'Certain Properties of Latex Phospholipin and their Variation with Age of Latex and Conditions of Preparation', and by G.W. Drake on 'Some Osmotic Measurements of the Molecular Weight of a High Molecular Weight Fraction of Rubber Hydrocarbon'.

In June the Division assisted in organising a meeting of the local Section of the Royal Institute of Chemistry, held at the Rubber Research Institute, at which Mr. R.W. Green of the University of Malaya gave a lecture on 'Collagen, the Protein of Leather.'

Contributions to the *Journal of the Rubber Research Institute of Malaya*, which were published during the year, were 'Report on

Technical Classification of Natural Rubber in Malaya' (Communication 277), and 'Mooney Viscosity Changes in Freshly Prepared Raw Natural Rubber' by R.I. Wood. The second issue of the New Series of *Planters' Bulletin* was wholly chemical and included 'Meeting the Consumers' Requirements', 'Technical Classification of Rubber: Estate Procedure', 'A New Rubber to Replace Leather', 'Precoagulation of Latex', 'Packing of Samples for Examination by Chemical Division', and 'A Rough Test for Bale Coating Powders'. The last contribution by this Division to the old series of numbered Circulars was 'Application of the R.R.I. Bleaching Process to the Preparation of White Latex Crepe' (Circular No. 35).

The new laboratories at Sungei Buloh became ready for occupation during July but, although apparatus was installed, a number of structural modifications were found necessary and laboratory work was not proceeding normally until the end of the year.

Experimental work during 1952 has been confined largely to the main lines of inquiry described in previous annual reports. Substantial progress has been made in most of the investigations undertaken, resulting in new and valuable basic data as well as useful practical achievements.

In fundamental research, emphasis has continued to be placed upon the study of the non-rubber substances in latex and the part they play in modifying the properties of both latex and dry rubber. The establishment of a routine method for preparing relatively large quantities of dry latex serum solids in a substantially unchanged state has provided essential raw material for investigations in the United Kingdom, where work on the separation and identification of latex proteins has made steady progress. Valuable advances have been made in Malaya in studying the phosphatides of latex, the major constituents of which have now been identified.

Work on the rubber hydrocarbon has been recommenced and although no major developments are anticipated, the objective in view, characterisation of the rubber molecule, will provide a valuable tool for differentiating between rubbers, and for following the changes in properties that occur in the course of preparation, transport and storage.

The Division has continued to be concerned with the quality of Malayan latex exports and application of recently developed laboratory tests to check field and factory practice has resulted in substantial improvements in the quality of concentrates produced on many estates. Two new systems for preserving latex at

CHEMICAL DIVISION

low concentrations of ammonia have now been established as satisfactory and are being followed up.

Investigations concerned with the technology of dry rubber have continued to follow two main lines of inquiry, namely, the application of technical classification to Malayan rubber production, and the study of rubber masterbatches prepared from latex by compounding directly with lignin and carbon black.

Trials made with rubber lignin masterbatches have been rewarding and rubber manufacturers are examining a compound having promising technological properties. The preparation of rubber carbon black compounds from latex masterbatches has not yet shown any major advantage over the customary dry mixing methods, although interesting modifications in technological properties of the vulcanisates can be obtained.

Technical classification of Malayan rubber has made notable progress; the volume of rubber shipped increased from 5,518 tons in 1951 to 17,100 tons in 1952. The reports of consumers' technologists on technically classified rubber have been generally favourable. An important development is the classifying of smallholders rubber packed in godowns, a few hundred tons having been shipped by the end of the year. Much work still remains to be done in applying technical classification to this type of rubber and to remilled grades; plans to augment staff and testing facilities have already been prepared, following discussions with the Rubber Producers' Council and our Board's decision to increase the volume of work in this field.

Investigations carried out at the Sungei Buloh factory have been concerned largely with advisory problems, although a systematic study of methods for baling sheet rubber for shipment has been commenced.

RESEARCH AND DEVELOPMENT

I

CHEMICAL & PHYSICAL PROPERTIES OF LATEX & RUBBER

NON-RUBBER CONSTITUENTS OF LATEX AND RUBBER

A technique for obtaining non-rubber constituents from fresh latex in a substantially unchanged condition was briefly outlined

in the *Report* for 1951; the method comprised coagulation of the rubber particles by freezing, mechanical separation of the serum after thawing, followed by freeze drying. The technique was put into routine operation, but during the year doubts arose as to whether this method of separating serum from rubber was completely satisfactory. It was observed that clear serum was obtained only if a relatively large surface area of frozen material was exposed to the air, as for instance, by freezing in shallow pans or by cutting the frozen latex into small pieces. The observations suggested that access of oxygen was giving rise to changes in the latex and modifying the properties of the serum substances finally obtained. An alternative method of separation was therefore sought.

Satisfactory separation of rubber and serum can be obtained by centrifuging fresh latex in the presence of a creaming agent, but the method was not found wholly suitable as the creaming agent had to be removed after drying. This was achieved by extracting the freeze dried serum with water or with buffer solutions, followed by further freeze drying. The final product was sticky, and difficult to handle.

Experiments were then undertaken to obtain segregation of rubber and serum by centrifuging fresh latex without the addition of a creaming agent. This required a high speed machine of a type not available in Malaya or the U.K. Samples of preserved latex were therefore forwarded for test to manufacturers of a suitable centrifuge in the U.S.A. The results were satisfactory and such a machine was received in Malaya at the end of the year. Preliminary experiments with fresh latex are promising.

Improvements in the efficiency of the freeze drying apparatus have also been made, to permit a larger throughput of material.

Latex protein - Samples of freeze dried latex serum have been forwarded weekly throughout the year to the British Rubber Producers' Research Association for examination, in whose laboratories a method of separation of the individual proteins has been worked out. Methods for identifying the proteins will be developed in the U.K. and it is hoped to undertake comparative studies of latex proteins in Malaya at a later date when the techniques have been established. Proteins are known to play an important part in conferring stability on latex and also in the mechanism of coagulation and drying; one object of the investigation is thus to establish the function of the individual proteins in modifying latex behaviour both in the field and in the factory.

Phosphatides — Work on the phosphatides (or phospholipins) in latex has made considerable progress. As described in a previous report the crude material has been prepared from latex by coagulation with alcohol, followed by evaporation of the serum to give an aqueous residue, from which the lipids are extracted with petroleum ether. The extracts contain other lipids besides phosphatides, but no attempt has been made to isolate the latter as the only readily available method, precipitation by acetone, proved to be unsuitable for latex phosphatides, some of which are soluble in acetone. Removal of water soluble impurities, presumably carried into petroleum ether solution by the peptising action of the phosphatide, was attempted in several ways, including dialysis, water washing, and partition chromatography.

Analysis of the crude material showed a phosphorus content of about 2.2 per cent of which very little was removed by purification; about 85 per cent of the total phosphorus was present as glycerophosphate. Nitrogen content varied considerably, depending upon conditions of preparation; in some cases 75 per cent of the nitrogen was present as choline. Up to 30 per cent total nitrogen was removable by purification. Fatty acids accounted for approximately 60 per cent of the material.

Further examination was undertaken by paper chromatography, carried out on hydrolysates of the lipids. After rigorous acid hydrolysis the presence of four carbohydrates was established, namely meso-inositol, galactose, glucose and glycerol. Under milder conditions, employing alkaline hydrolysis, more complex substances were found to be present. These, however, could be further hydrolysed to give the same four basic carbohydrates. None of the constituents was removed by purification. Hydrolysates were also shown to contain a number of ninhydrin reacting substances, chiefly amino acids, all of which were substantially removed by purification with the exception of ethanolamine, which thus appeared to be combined with the lipids.

Earlier experiments already reported indicated that the properties of the phosphatides obtained from latex were markedly dependent on the method of preparation. The ratio of choline nitrogen to total phosphorus in particular showed wide variation. It was originally considered that the differences were due to changes proceeding in the freshly tapped latex, but more recent observations show that the changes occur after the addition of alcohol to the latex. Data at present available suggest that phosphatides extracted from latex by coagulation in boiling alcohol are substantially in the form existing in the tree. This material has

a choline N/P atomic ratio of *circa* 0.75, indicating that 75 per cent of the phosphatide probably occurs as lecithin; the remainder possibly consists of phosphatidyl ethanolamine and metal salts of phosphatidic acid. If, however, coagulation with alcohol is carried out at 30°C or lower, it is found that a progressive liberation of choline from the lipid occurs on standing. After a few hours' storage of the coagulated mixture the lipid obtained had a very low choline N/P atomic ratio; in one instance the ratio dropped to 0.10, whilst a corresponding amount of free choline appeared in the serum. Rapid liberation of choline also occurred when formic acid was used to coagulate latex, the lipids extracted containing no choline nitrogen at all. The factor responsible for splitting off choline from the phosphatide was thus inactive in latex, but was rendered active in the presence of alcohol or of formic acid. Experiments have shown that it is rendered ineffective by heating at temperature above 50°C. Storage of latex at 30°C was also found progressively to decrease the activity of the choline liberating factor, when alcohol was subsequently added.

The liberation of choline from the phosphatides results in the formation of free phosphatidic acid, which would be expected to form salts with any metallic ions present. The consequent increases to be expected in the ash content of the lipids and in the proportion of the total phosphorus found in the ash have been confirmed experimentally.

Lutoids in latex — A means was sought to stabilise lutoid globules against disruption or agglomeration when latex is diluted, with a view to ultimate separation of the lutoids from the rubber phase. Control of the pH and of the osmotic pressure of the solutions employed were not markedly effective. Addition of sodium metasilicate or of silica sols was found to be one means of stabilisation.

Acid and base content of dry rubber — The methods described in the previous Annual Report for determining acidic and basic materials in dry rubber, do not permit discrimination between the types of acids or bases present. In order to do this, attempts have been made to separate from rubber all the titratable material present with a view to subsequent analysis. The most promising method so far developed is to separate acids from rubber by passing a solution of the latter through an alumina column, which retains over 90 per cent of the titratable acidic material. Subsequent elution of the acids from the column appears to be complicated by the adsorption of rubber on the alumina, and a satisfactory method has yet to be devised. Extraction of bases

from rubber appears to present an equally difficult problem, a maximum of only 60 per cent of the titratable bases having been retained on the absorption columns tried so far.

CHARACTERISATION OF RUBBER HYDROCARBON

One object of the investigations at present being undertaken on the molecular characteristics of the rubber hydrocarbon is to devise a suitable procedure which will permit differentiation between rubbers, and will enable changes during preparation, treatment and storage to be followed. The present method is to divide the hydrocarbon into two fractions, one of which is soluble (sol) and the other insoluble (gel) in benzene under standard conditions. The soluble rubber is then divided into three fractions on the basis of solubility in benzene isopropanol; osmometric and viscosimetric molecular weights are then determined on each fraction. This gives a general picture of the molecular weight distribution of the sol rubber. A means of characterising the gel rubber awaits development.

The separation of rubber into sol and gel fractions requires considerable care. It has recently been established that direct swelling of rubber in excess solvent, followed by decantation of the soluble from the insoluble portion, seriously overestimates the gel content. The swollen gel retains a considerable proportion of soluble rubber, which is only completely removed after a number of static extractions with pure solvent. Rubber removed by a second static extraction shows a higher viscosity than that from the first, suggesting that the material of higher molecular weight is more difficult to remove. Most of the sol rubber can be removed in one extraction provided slow stirring or gentle lateral shaking of the swollen gel is employed. If the agitation is too vigorous a partial breakdown of the gel structure results, with the formation of a 'soluble' rubber resembling microgel. There is some evidence that on storing the 'soluble' microgel rubber in absence of air, a macrogel structure partially reforms.

The problem is further complicated by the possibility that during vacuum drying of rubber hydrocarbon fractions, changes in molecular structure may occur, similar to the hardening observed in these laboratories during dry storage of solid raw rubber. Recent experiments have shown that during normal vacuum drying, when specific viscosity divided by concentration is plotted against concentration, the slope is considerably altered, although in some cases the viscosity extrapolated to zero concentration was unchanged.

CHANGES OCCURRING IN AMMONIATED LATEX

Progress in the study of chemical changes occurring in freshly ammoniated latex has been hindered by difficulties in interpreting certain anomalous results from analytical determinations. Considerable time has been spent in investigating the analytical methods used, particularly in developing a means of taking a representative sample from the bulk. Data so far obtained suggest that extreme precautions must be taken to ensure that latices are homogeneous before and during sampling.

Examination of a number of commercial concentrates indicated that an increase in the acid associated with the rubber phase occurred during the first few weeks after preparation. An estimate of the acids was obtained by titrating both ammoniated whole latex and the serum separated from it by creaming. The increase in acid associated with the rubber phase showed a significant correlation with the increase in mechanical stability of the concentrate, and may be due to absorption of fatty acid soaps at the rubber/serum interface. With latices from clone Glenshiel 1, no acid appeared to be associated with the rubber particles even after a few weeks' storage.

MICROBIOLOGY OF LATEX

A microbiological study of latex was commenced towards the end of the year in collaboration with the Pathological Division. The work is exploratory and will be largely concerned with a survey of the microflora present in latices from a typical estate factory.

COPPER INJECTION OF HEVEA BRASILIENSIS

Statistically planned trials carried out on a block of trees at Sungei Buloh in collaboration with the Botanical Division have shown that injection with copper and other yield stimulants has no appreciable effect upon the properties of the latex obtained. Centrifugal concentrates were prepared at intervals covering a period of six months after injection; they were tested immediately after preparation and again after two months' storage. The copper content of the latices was normal. Smoked sheet prepared from the latices showed normal vulcanising behaviour. A second injection was given to the trees during October 1952, and further samples of latex are being examined.

CHEMISTRY AND TECHNOLOGY OF LATEX

TEST METHODS

Mechanical Stability -- Experiments carried out on different latices indicated that the relationship between temperature of test and mechanical stability was reasonably linear over the range 30° to 40°C. Values decreased by 15 to 20 per cent when the temperature was increased from 30° to 40°C. Pewter containers were found preferable to perspex ones, as they showed smaller changes in temperature during the course of the test.

In the mechanical stability test, it is apparent that much ammonia is lost during the testing operation; experiment showed that the ammonia content is usually reduced from 0.6 to 0.3 per cent. Ambient conditions were found to influence the rate of loss of ammonia and thus to affect the value for mechanical stability obtained; conditions under which the test is carried out should therefore be taken into account as one of the factors liable to cause variability in the data.

The method of determining the endpoint for the mechanical stability test is by visual observation of agglomeration of the particles; it is open to the criticism that a personal bias may easily be introduced. Measurements of surface area of the disperse phase clearly showed that agglomeration does not occur for a considerable period, and then increases slowly as coagulation is approached.

KOH Number — The use of an external indicator, Brilliant Orange, has been suggested by the London Advisory Committee for routine determination of the KOH number of latex, thus avoiding the use of a pH meter. Trials with the indicator gave results in reasonable agreement with electrometric titration, and might well find application for routine testing.

Volatile Acids — The determination of volatile acid content has proved to be a valuable routine measure in assessing the quality of latex, both field and concentrate. The method used is somewhat lengthy and efforts have been made to reduce the period required. Distillation of the acids has usually been carried out from latex serum but recent experiments suggest that distillation from the whole latex may be possible if certain precautions are taken, thus saving the time required for separating serum from latex. Comparison of a number of standard stills showed no definite advantage for any one type, and no marked improvement in distillation time was effected.

Chromatographic methods for isolating volatile acids have also been tried, but so far have not been found suitable for routine use.

The most promising development is, perhaps, the observation that results accumulated over nearly two years indicate that a close approximation to the true volatile acid content can be derived from the acid present in the first 50 ml of distillate. For routine estimates the time of test is thereby reduced to about one hour.

Surface area of latex globules — A method of assessing the surface area of the disperse phase in latex has been studied by COCKBAIN (*Trans. I.R.I.* 28 (1952) 297) working at the British Rubber Producers' Research Association. The procedure consists in titrating latex with a highly surface active soap which is adsorbed at the rubber/serum interface until saturation is achieved. Excess soap added then passes into solution. The endpoint of the titration is indicated by colour change in a dye, which occurs when the critical micellar concentration of the soap is reached. From the difference in the quantity of soap required in the presence and in the absence of a known amount of latex, an estimate may be made of the area of the rubber/serum interface and hence, of the average latex particle size.

Marked differences have been observed between estimates of interfacial surface area obtained in the U.K. and in Malaya with samples of the same latex. This was traced to the marked dependence upon temperature from which the determination suffers; in one instance values showed 50 to 100 per cent increase as the temperature was changed from 30°C to 22°C.

It has now been demonstrated with a number of field and concentrated latices, that the relative values of surface area are unaffected by temperature, provided the series of determinations are all made at the same temperature.

Using this method, it has been observed that the relatively unstable latex from clone Glenshiel 1 has an abnormally high surface area of the disperse phase. Further experiments, which have yet to be confirmed, have indicated that certain other clones yielding somewhat unstable latices also showed a high surface area.

PRESERVATION

Results of tests upon a number of new reagents used for preserving latex concentrates are now available. Earlier in the year, samples of the latices were forwarded to the London Advisory Committee for examination, and samples retained in Malaya.

CHEMICAL DIVISION : RESEARCH

After a period of nine months, whether stored in Malaya or shipped and stored in London, latices containing the following additions were in good condition :

- 1 Ammonia 0.2% and acriflavine 0.01%
- 2 Ammonia 0.1%, ethylenediaminetetracetic acid 0.1% and sodium pentachlorophenate 0.1%
- 3 Ammonia 0.2% and ethylenediamine tetracetic acid 0.1%

In latex (1) acriflavine unfortunately imparts a bright yellow colour to the latex and recent advice from consumers indicates that it would not generally be acceptable. An attempt will be made to find similar alternative materials which do not suffer from this disadvantage. In latex (2) the combination of ethylenediamine tetracetic acid and sodium pentachlorophenate permits the use of lower concentrations of ammonia than the use of either of these reagents alone and gives a higher mechanical stability, and thus shows advantages over the use of ethylenediamine tetracetic acid and ammonia alone, for which the patent has been taken out by a commercial organisation. It is hoped to arrange trials of this type of concentrate by latex consumers.

Latex preserved with 0.2 per cent ammonia and 0.2 per cent zinc oxide showed a low mechanical stability, but was otherwise in good condition.

A number of bactericides including quarternary ammonium compounds and other cationic detergents were ineffective at low concentrations both with and without low concentrations of ammonia. Cetyl pyridinium chloride was found to preserve and to cream fresh latex at concentrations over 0.9 per cent, based on the latex. The resulting concentrates were viscous, but the viscosity could be reduced considerably by adding an acid.

III

CHEMISTRY & TECHNOLOGY OF DRY RUBBER

MODIFYING THE CHARACTERISTICS OF THE RUBBER HYDROCARBON

It has been shown (G.F. BLOOMFIELD *Rubb. Developm.* 5 (1952) 38) that the molecular characteristics of the rubber hydrocarbon can be modified by treating ammonia preserved latex with amine peroxide redox systems similar to those used in the polymerisation processes of synthetic rubber production.

Experiments with fresh latex have now shown that rubbers having a Mooney viscosity of about 200 can be prepared by this process without difficulty. Unfortunately supplies of suitable reagents are difficult to obtain in Malaya, as the organic peroxides employed are regarded by transport authorities as dangerous commodities; they also deteriorate rapidly under tropical conditions. Trials were also made with inorganic redox systems which suffer far less from these disadvantages; the products were not satisfactory as they showed considerable degradation of the hydrocarbon. The search for more suitable peroxides continues, the most successful one to date being cumene hydro peroxide.

Experiments carried out at the British Rubber Producers' Research Association have shown that products with technological properties resembling those of filler reinforced stocks can be obtained by the polymerisation of methylmethacrylate in the presence of natural rubber latex. The tough and hard 'transfer polymers', as they are termed, have the advantage of being comparatively light in colour. Attempts in Malaya to bring about the polymerisation in fresh latex were not successful at first and further study of the system is proposed.

ALTERNATIVE 'BLEACHING' AGENTS FOR PALE CREPE

Nitrogen trichloride is known to be an effective bleaching agent for flour, and attempts have been made to use it for removing the yellow colour from latex. Although the colouring matter could be bleached by the reagent after extraction from first fraction crepe rubber, experiments in which nitrogen trichloride was introduced directly into latex were not successful; in some, darkening of the crepe resulted.

Fluorescent dyes which are activated by ultra violet light have been developed for use in laundering and in advertising posters where the increased brightness of the surface is of value. The introduction of a similar dye into latex with the object of obtaining a bright white crepe was not successful as the rubber became slightly discoloured and was softened by the treatment. Although the crepe showed marked fluorescence under ultra violet light, there was no evidence of increased brightness when viewed in Malayan daylight.

TECHNOLOGICAL TESTING METHODS

Schopper machine—Variations in the elongation of a stretched ring whilst undergoing test on the Schopper machine indicated that errors involved in the measurement of high elongation modulus

by this method are likely to be relatively large for high modulus rubber. The errors found for low modulus rubbers could be described adequately by the equation suggested by the American Bureau of Standards (Circular No. 38).

Strain Test—Considerable variations have been obtained in the cross-sectional area of the moulded test pieces used for the strain test. Direct measurement established that the variability occurred in the width, rather than in the depth of the dumbbell, suggesting distortion of the mould cavity walls during vulcanisation. Experiment showed that the mould distortion did not remain constant, so that selection of 'good' cavities and rejection of 'bad' ones was not feasible. For accurate results it is thus necessary to apply a correction for cross-sectional area; this is particularly important with low modulus rubbers (strain value *circa* 100) where small errors in cross-section lead to large numerical errors in strain value.

Determination of rubber hydrocarbon—Comparison of the Gowans and Clark bromination method for the determination of rubber hydrocarbon with the chromic acid oxidation method has indicated similar standard errors in the two cases ($\pm 0.15\%$ and $\pm 0.23\%$ respectively). The actual values given by the bromination method were slightly lower. From the data obtained the bromination method did not appear substantially more accurate; it has the disadvantage of being more laborious

MASTERBATCHES PREPARED FROM LATEX WITH LIGNIN OR CARBON BLACK

Rubber lignin—Progress in developing rubber lignin masterbatches has been slow, but the considerable amount of time devoted to this work has now been rewarded by a promising product with somewhat novel properties.

The nature of the final vulcanised product is considerably influenced by the conditions under which the masterbatch is prepared. Thus shock coagulation of the latex lignin mixtures with hot sulphuric acid confers higher tension strength, higher modulus and considerably greater resistance to tear, whereas normal cold coagulation with formic acid results in products showing higher resilience.

The use of more powerful acceleration than that normally employed for tyre tread stocks has been found essential if good technical properties are to be obtained in the vulcanisates. Provided the rubbers are given the correct cure, the ageing characteristics of the highly accelerated lignin compounds compare favourably with those of an MPC tyre tread stock, no antioxidants being

employed in either. Hot milling of the masterbatch with hexamethylene tetramine has been recommended by other workers in this field as conferring improved technical properties and this has been confirmed. The use of other accelerators in the same manner, such as Santocure and TMT, were found to confer similar benefits. Experiments in which both carbon black and lignin were compounded with rubber gave rise to a series of products showing interesting technical properties which are worthy of further investigation. Samples of rubber lignin masterbatches forwarded to the U.K. for trial have been favourably reported upon by the London Advisory Committee and further samples have been submitted to rubber manufacturers for evaluation.

Although satisfactory products can be made in the laboratory, much development work would have to be carried out before production at a pilot plant level could be achieved. For economic production a source of lignin not too distant from Malaya would also be required. Lignin is a by-product of the paper pulp industry and so far Canadian lignin has been employed for the experimental work carried out. Supplies have also been obtained from Australia but no trials have yet been made with this material. Investigations along these lines will be continued provided manufacturing interests give satisfactory reports on the masterbatches already supplied.

Rubber carbon black — Further work on rubber carbon black masterbatches has now permitted a more general assessment of the value of these materials. Properties of tyre tread compounds prepared with rubber MPC black masterbatches appear on the whole to be comparable with those given by dry mixing, save that a finer dispersion of the black is usually obtained, which results in higher modulus and lower resilience in the masterbatch stocks. There is a tendency for masterbatch compounds to scorch easily. The effect of masterbatching upon resistance to abrasion has not been studied sufficiently to permit definite conclusions to be drawn.

In contrast with rubber lignin compounds conditions of coagulation are without marked effect upon the properties of rubber carbon black mixtures. It is concluded that the method of preparation previously adopted is likely to give as good a product as any. This consists in preparing a carbon black slurry by ball milling in water, with or without the addition of lignin dissolved in sodium hydroxide solution to assist dispersion. The slurry is then stirred into latex and the mixture coagulated with cold formic acid.

An interesting observation, which should be of value if commercial production is undertaken, is that a considerable reduction

in drying time can be effected by using hot water on the mill used for creping the masterbatch coagulum. By using washwater at a little over 50°C, crepes were obtained which dried at room temperature within twentyfour hours; at higher temperatures, more rapid drying was obtained.

Samples have been sent to the U.K. for evaluation.

IV

PREPARATION PRACTICE

PACKING

The proposed trials in which experimentally packed bales are to be shipped to and examined in the U.K. have been commenced and the first consignment has been reported upon by the London Advisory Committee. Conclusions regarding the methods of packing will not be drawn until further similar shipments have been made. It is proposed to run three consignments on each type of packing, the times of shipment being spread over the year, in order to encounter conditions of transit as varied as possible.

The first series of trials was designed to try out the fibre-board cases recommended as an outer cover for smoked sheet by the Packing and Allied Trades Research Association. Preliminary observations showed that the corners of the cases were particularly susceptible to damage and special methods of packing which fill the cases more completely have been developed for future trials. Both polythene sheet (0.002 inch) and R.M.A. bale paint were found to prevent adhesion between rubber and fibreboard. R.M.A. bale paint also prevented adhesion between sections of the bale, which comprised three 80 lb layers; a single layer of polythene was not effective for this purpose.

Attention has also been given to laboratory test methods by which the resistance of bales to deformation can be evaluated. So far laboratory tests do not line up with behaviour during shipment and further studies need to be undertaken. The effect of intensity of pressing upon the compactness of the finished bale is also being examined.

NEW PROCESSES

Line ahead creping battery — The outstanding section of the line ahead creping battery has now been installed. After a few trials mechanical faults developed which were still receiving attention at the end of the year.

Continuous process for preparing dry rubber — Further experimental work has confirmed earlier finding that proteins have an important influence upon the resistance of fresh coagula to stretching. Attempts to reduce this adverse influence of the protein have not been particularly successful, although it was demonstrated that the addition of formaldehyde increased the toughness of the coagulum. As it was thought possible that formaldehyde was effective because it tanned the proteins, a variety of tanning agents was tried, but on the whole proved ineffective.

It has become obvious that work on the structure of coagulum requires to be carried out at bench level before further progress with this undertaking can be expected.

LARGE SCALE PREPARATION OF SPECIAL RUBBERS

Rubber powder — Manufacture of rubber powder was continued until July, when sufficient stocks had accumulated for the proposed experimental road programme in the U.S.A. Over 50 tons were produced during the half year. During the early part of the year, improvements in the fineness of the powder produced were achieved by increasing the proportion of vulcanising ingredients. This had the disadvantage of rendering the powder less readily soluble in bitumen and was finally abandoned when it was found that an equally fine powder could be produced with the normal quantity of vulcanising ingredients provided finer screens were used in the hammer milling operation. Rate of throughput was only slightly reduced by this procedure.

Reports from the U.S.A. indicated that 2 to 3 per cent of talc was insufficient to prevent massing of the powder during transit and storage. Experiments carried out in Malaya showed that 4.5 to 5 per cent of talc was required if the powder was to remain free flowing after a few months' standing. Reduction of the bulk density on packing was also found to lessen compaction after transportation.

Cyclised rubber — Earlier experimental work carried out by the B.R.P.R.A. and R.T.D. Ltd established a method for the production of cyclised rubber at the pilot plant stage, and demonstrated its value as a shoe soleing material. Properties were similar to those of the high styrene butadiene copolymers which were finding a ready market by mid-1952. The R.T.D. process permitted the production of cyclised rubber from latex preserved with ammonia or from fresh latex and it was thus possible to manufacture the material either in the U.K. or in Malaya. A comparison of the cost of production in the respective countries was undertaken at the request of the Board of R.T.D. Ltd

CHEMICAL DIVISION: RESEARCH

Before setting up pilot plant production in Malaya, a member of the B.R.P.R.A. staff was seconded to undertake preliminary laboratory work, adapting the method of preparation to eastern conditions. This was successfully achieved and a pilot plant was set up at Sungei Buloh by a member of R.T.D. staff. At the end of the year some 1000 lb of cyclised rubber masterbatch (half rubber, half cyclised rubber) had been produced. The material was judged satisfactory by laboratory tests, and further supplies for evaluation by manufacturers will be produced at Sungei Buloh. Figures comparing the cost of production in the U.K. with that in Malaya are not yet available. A difficulty met with in commercial production in the Far East is the high cost of the sulphuric acid which is employed in the process, coupled with the problem of disposing of large quantities of the comparatively strong impure acid which remains after cyclisation is completed. Economic production would undoubtedly be assisted if a market for the spent acid could be found.

ADVISORY

THE VOLUME OF GENERAL ADVISORY WORK remained much the same as during the previous year. Office records show the following:

Interviews, Headquarters and E.S. Factory ...	289
Visits	163
Letters & Reports	2,977
Samples examined (excluding those examined in connection with technical classification)	1,582

Inquiries covered a wide field, ranging from the testing of metrolacs to the design of factory layouts. The topics requiring most attention comprised: quality of latex concentrate; defects in sheet and crepe; and the R.R.I. bleaching process for preparing pale crepe. Apart from work on technical classification, routine laboratory testing was largely concerned with determinations of dry rubber content and other properties of latex together with estimations of the rubber content of scrap rubber for customs purposes.

A brief account of the more important investigations arising in connection with advisory problems is recorded below. A list of advisory publications issued during the year is given on page 74. An advisory leaflet C/AL 15 (52) 'Notes on Latex Anticoagulants' was prepared for issue as required.

QUALITY OF LATEX CONCENTRATES

A considerable amount of experimental work has been carried out in cooperation with estates in attempts to improve the quality of latex concentrates. The presence of unduly high concentrations of volatile acids was found each time to be the cause of poor quality, indicated by low mechanical stability and high KOH number. Marked improvement was obtained by exercising greater care in collection and processing, particularly by early and adequate ammoniation of latex and by avoiding long periods of storage of field latex before processing.

A series of latices have been prepared which contain known quantities of volatile acids, developed by natural putrefaction under controlled conditions. Samples of the latices have been forwarded to the London Advisory Committee for examination, in connection with complaints received in the U.K. concerning the quality of Malayan latex supplies. It is hoped to obtain further information regarding the effect of volatile acid content upon technological behaviour.

LATICES FROM CLONES RRIM '500' AND
RRIM '600' SERIES

Examination of latices from budded trees of the RRIM '500' and RRIM '600' series has been carried out on material collected from the original trees at the R.R.I. Experiment Station, stabilised with 0.5 per cent ammonia and concentrated by centrifuging. The concentrates were tested in respect of KOH number, volatile acid content, mechanical stability and viscosity, immediately after preparation and after standing for two months. The following clones appeared to be satisfactory for the preparation of concentrates by centrifuging judged by mechanical stability and viscosity: RRIM 508, 509, 511, 513, 516, 526, 601, 606, 607, 609, 612, 614, 615, 617, 620, 623 and 629. Clones RRIM 520 and 602 gave latices which might be satisfactory but about which there was some doubt. Clones yielding latices which were not regarded as satisfactory were RRIM 501, 519, 521, 527, 600, 604, 605, 608, 610, 613, 616, 618, 619, 621, 622, 628 and 630. It should be noted that these conclusions apply specifically to latices from trees planted at Sungei Buloh. The trees are young and it is emphasised that it must not be assumed that the results obtained in this study will necessarily be repeated under all conditions. Data is obtained in these tests for the guidance of the plant breeder in selecting clones for commercial planting and for use as parents in further breeding work.

CHEMICAL DIVISION: ADVISORY

MACHINING AND DRYING COAGULUM

No appreciable difference in behaviour on machining or drying was found when sheets from a tank ten feet long containing 95 partitions and coagulated at a dry rubber content of $1\frac{3}{4}$ lb per gallon were compared with sheets from a similar tank containing 75 partitions, coagulated at $1\frac{1}{2}$ lb per gallon.

The volume shrinkage of machined coagulum during drying has been determined, using a water displacement method for estimating density and correcting for water absorption where necessary. Data obtained on rubbers containing up to 20 per cent moisture could be expressed approximately by the equation:

$$D = 0.908 + 0.0007W$$

where D = density of wet rubber in gm/ml at 27-29°C

and W = moisture content of rubber per cent.

Comparison of coagula prepared from latices of clones PB 186 and Tjir 1 showed no appreciable difference in tendency to tear during machining. The trial was carried out as the two clones yield soft and hard rubber respectively, which might be expected to influence behaviour on machining.

NOVEL SHEETING BATTERY

At the request of the manufacturers the prototype of a novel compact sheeting battery has been installed in the factory for use in the routine preparation of sheet. It is too early to give a report upon performance, as teething troubles are still being experienced.

DRYING SHEET RUBBER

The possibility of drying and packing full length sheets has been examined. For drying in R.R.I. type smoke houses, the dimensions of the latter and of the trucks would require modification, although the adjustments appear quite practicable. The truck space for a given weight of rubber would be almost the same, but the total beroti length required would be about one and a half as much. Packing full length sheets into bales presented no difficulties and under the conditions employed (18 hours under compression) the bales showed no abnormal behaviour. Packing can be facilitated if the depth of latex in the coagulating tank is adjusted to give a final sheet equal in width to that of the baling box.

Although air drying has many advantages over smoke drying from the purely practical point of view, air dried sheet suffers from a serious disadvantage in its susceptibility to contamination by moulds. Two approaches to the problem have been made.

In the first instance a modified method of drying has been tried, whereby sheets were dried for one day in smoke and then transferred to an air drying shed for final drying. Samples have been submitted to the trade for opinions as to whether this type of sheet would be tenderable as RSS. The total drying time was four fifths of that required for normal smoke house treatment. Preliminary tests indicated that mould developed a little more quickly on the partly smoked sheets than on normal smoked sheets.

A second approach followed the suggestion that an alternative means of incorporating smoked ingredients into sheet could be employed. Such processes have been worked out for other materials, for instance fish, and successfully avoid the necessity of the actual smoking operation. Preliminary trials were carried out with Fumeol, a partially purified wood tar, which was introduced into latex prior to coagulation. The sheets obtained were of a dull, dirty brown appearance and had poor resistance to contamination by moulds.

R. R. I. BLEACHING PROCESS FOR PREPARING PALE CREPE

A number of interesting observations have been made on the use of xylyl mercaptan as a bleaching agent for removing the yellow colour from latex used in the preparation of pale crepe. For a range of latices examined, the optimum quantity of bleaching agent was 0.04 to 0.05 per cent; as a rule larger quantities gave a grey tint to the crepe and caused softness, whereas less than 0.04 per cent gave incomplete bleaching of whole latex. Exposure of the machined bleached coagulum to daylight was found to have a beneficial influence on the colour of the final product. The recommended procedure is to expose the wet crepe to diffuse daylight for a period of half a day to three days. Longer exposures cause the bleached crepe to turn brown.

Judging from laboratory experiments sodium sulphite, formalin, or formalin with sodium carbonate, are suitable anticoagulants for use with latex intended for the production of bleached crepe. Ammonia causes discolouration.

Supplies of a commercial preparation containing xylyl mercaptan and a suitable emulsifying agent became available about the middle of 1952 ('Emulsion A concentrate') and permit direct preparation of the bleaching emulsion on estates. The manufacture of Emulsion A by the Division was discontinued; over 4,000 gallons had been supplied during the first six months of the year.

CHEMICAL DIVISION: ADVISORY

BALE COATING POWDERS

A number of locally available 'talcs' have been assessed for their value as bale coating powders. Precipitated calcium carbonate was shown to be superior to talc as to stability of the bale coating solution, covering power, resistance of the coating to rubbing, and dispersion of the bale coating in rubber when the latter was masticated on a mixing mill. Slip characteristics were inferior to those of a high grade talc.

Some of the lower grade talcs showed poor coverage after subjecting to surface attrition but most of the coatings, including kaolin, dispersed readily when the rubber was milled. A local magnesium calcium carbonate was found difficult to disperse when tested just after the application of the coating, but was satisfactory after a few weeks storage of the bale. Although a number of the 'talcs' appearing on the market are poor in quality some locally produced powders appeared to be perfectly satisfactory although not strictly conforming to the current R.M.A. specification.

TECHNICAL CLASSIFICATION OF NATURAL RUBBER

Progress in the routine technical classification of natural rubber has been maintained steadily throughout the year. At the end of 1951, fortytwo estates had been allocated class marks; at the end of 1952, ninetyeight estates were forwarding regular samples for test and seventyfour were actually marking bales. The rate of output increased from 10,000 tons per annum at the commencement of the year to over 20,000 tons per annum at the close. Rubber classified by the Rubber Research Institute Testing Station amounted to 14,846 tons during 1952. Reports from consumers' technologists upon supplies of technically classified rubber from Malayan and other sources have, on the whole, been favourable.

Classification of estate rubber has been considerably assisted by the development of special techniques which permit control of vulcanising characteristics of the rubber produced, within certain limits. The produce of five estates which unfortunately fell on the borderline between two classes has been satisfactorily modified, and is now being classified. This has been accomplished without any deleterious effect upon quality, and all reports upon the rubbers have so far been satisfactory.

An advance in testing procedure enables evaluation of vulcanising properties to be made within one working day, as opposed to three days required by the earlier method. A further refinement in testing has reduced errors due to variation in cross-sectional area of the test pieces used in the strain test. Alternative

tests for classifying raw rubber have also been examined, but were found to be more time consuming, without giving any definite advantage over the present method.

A most important advance in this field has been the extension of technical classification to smallholders rubber graded and baled in packing houses. During the latter part of the year some 250 tons of RSS 3 from packing houses was classified. Cooperative experiments with packing houses have shown that modification in the routine packing procedure employed is essential before the bales can be classified. With normal packing procedures, consignments of rubber show marked heterogeneity of vulcanising characteristics between bales. By using a suitable blending technique the variation between bales can be significantly reduced and reliable technical classification of the rubber usually becomes possible. The further development of this branch of technical classification will probably be slow, as up to the present each godown has required individual investigation.

In one instance, examination of smallholders sheet from the different localities supplying the godown showed the produce from within each area to possess reasonably consistent properties over a period of time, while the values for the different areas showed considerable divergencies. This effect has been exploited in order to improve blending efficiency in reducing bale to bale variation.

Considerable difficulty was experienced in classifying consignments of RSS 3 from one godown because the mean level of properties fell close to the borderline between the yellow and blue classes. In order to obtain manufactures' opinions on the value of this material, the introduction of overlapping classes has been adopted as an experimental and temporary measure, the rubber in this instance being marked yellow/blue.

The decision of the Board to extend laboratory facilities and to increase the staff engaged upon this work will permit more rapid advance in applying technical classification both to rubber packed in godowns and to remilled rubbers.

SULPHURIC ACID COAGULATED SMOKED SHEET

The quality of smoked sheet rubber prepared by coagulation with sulphuric acid has again been in question, complaints regarding technological behaviour having been received from the U.K. A series of tests have been carried out on estate produced sheet coagulated with sulphuric and formic acids, six bales being prepared from the same bulk of latex, three with each acid. Samples were taken before shipment of the bales and again on arrival in the U.K.

CHEMICAL DIVISION: ADVISORY

Technological tests were carried out by the British Rubber Producers' Research Association, the London Advisory Committee and the Rubber Research Institute of Malaya. Manufacturers' evaluation has also been received.

Laboratory data indicated that the use of sulphuric acid had no marked effect upon the modulus of A.C.S. No. 1 vulcanisates, although the rubber was apt to be slightly softer. Behaviour under manufacturing conditions confirmed these findings. Storage of the rubbers for nine months under tropical conditions revealed no abnormality in their behaviour.

A further series of rubbers prepared with sulphuric and with formic acids, both on smallholdings and on an estate, have now been forwarded to the Research Association of British Rubber Manufacturers for thorough investigation in an effort to settle this recurrent problem.

W.G. WREN

Head of Chemical Division

SMALLHOLDERS' ADVISORY SERVICE

THE SMALLHOLDERS' ADVISORY OFFICER, Mr L.R. Davidson, was absent on long leave from March to November and during this period Mr J.M.F. Greenwood was in charge of the service. Much of the work recorded in this report took place while Mr Greenwood was Acting Smallholders' Advisory Officer and has been taken from his reports. Mr Greenwood was on duty throughout the year and Mr J.W.L. Bevan arrived from Britain to assume duty in November, as Assistant Smallholders Advisory Officer.

With only one senior officer on duty for the greater part of the year visits to Rubber Instructors were necessarily fewer than in 1950 and 1951. Perak, Kedah, Province Wellesley and Johore were covered in two major tours and Rubber Instructors in Selangor, Negri Sembilan, Malacca and Pahang were visited singly as occasion arose.

Inche Mohd Aris bin Ahmad Fathil, Superintendent Rubber Instructor (S.R.I.) Johore, resigned in June. Inche Shamsuddin bin Mohd Arabee was then transferred from Baling to act as S.R.I. Johore and was confirmed in the appointment with effect from 17 November. Mr G. Diaz, S.R.I. Selangor, Negri Sembilan and Malacca, was on long leave from June to December, including a month's study leave when he took a course in farm mechanisation at the Ferguson Training School, Leamington Spa. Mr Eu Eng Hoe acted for Mr Diaz during his absence.

Five new Chinese Rubber Instructors were appointed in April and after training at the R.R.I. Experiment Station and with senior Rubber Instructors they were posted to their first stations in June. Two Rubber Instructors resigned during the year. One took up an appointment with the Rural & Industrial Development Authority, while the other obtained appointment as an Assistant State Replanting Officer. Five permanent transfers had to be made during the year and wherever possible advantage was taken of long leave arrangements to minimise disturbance to the service and to Rubber Instructors personally. In addition, two temporary transfers were necessitated by the importance of providing supervision of Demonstrators in the remote districts of Kelantan and East Pahang. A Malay and a Chinese Rubber Instructor, both from Selangor, were moved to meet these requirements.

With a fall in the total number of Malay Rubber Instructors, aggravated by the incidence of long leave, arrangements had to be made to continue with a reduction in the Malay complement in Selangor, Negri Sembilan and Kedah. There has been some compensation for this in the recruitment of new Chinese Rubber Instructors. For the first time a Chinese Rubber Instructor has been

stationed at Sungei Patani, while additional Chinese Rubber Instructors have been available in Selangor and Perak.

Six Rubber Instructors spent periods of one to two months on the R.R.I. Experiment Station to provide supervision for training courses under the Colonial Development and Welfare (C.D. & W.) Scheme and for the instruction of new Rubber Instructors.

Fifteen Rubber Instructors had long leave during the year. The total loss to the service was equivalent to approximately 36 instructor months or 8 per cent of its potential. This is the highest level of leave incidence since 1947, when the accumulated leave of the occupation years was taken, and it is the natural sequence to that period. Two Rubber Instructors, Aw Yong Kong Keong and J.G. Samuel, have been awarded scholarships to enable them to study agriculture for B.Sc. degrees, in the United Kingdom and India respectively, and have temporarily left the service. At 31 December there were 37 Rubber Instructors in the service.

The Board has approved the principle of providing accommodation at permanent Rubber Instructors' stations where difficulty is experienced in obtaining quarters. Application has been made for funds to start building houses and in the meantime opportunities are being taken to secure leases of private houses. Provision of houses in all permanent stations will considerably facilitate the smooth working of the service.

In 1952 we have taken steps to increase the cadre of Rubber Demonstrators from the young men trained under the C.D. & W. Scheme. There has been a total intake of 19 new men engaged for a probationary period of three months, while losses from inability to secure confirmation of appointment, termination of service and resignation have numbered 8. There was thus a net gain of 11 Rubber Demonstrators and the total at the end of the year was 54. This increase has been divided fairly evenly between the different territories: only in Selangor, Johore and Trengganu have the numbers remained at the 1951 level, while Negri Sembilan (3), Perak (2) and Pahang (2) have received the greatest benefit. New Rubber Demonstrators have been appointed according to the needs of the districts and the availability of suitably qualified men. It is unfortunate that in Trengganu we have not been able to obtain our requirements because insufficient men from this State have attended the training courses at Sungei Buloh. We hope to be able to arrange special training for the men we need in Trengganu in 1953. Two Rubber Demonstrators have been on duty at the R.R.I. Experiment Station at all times during the training courses and a total of eight of the best Demonstrators have been allocated to this work during the year.

SMALLHOLDERS' RUBBER ADVISORY COMMITTEE

The eleventh meeting of the Smallholders' Rubber Advisory Committee took place in October. Estimates for expenditure were considered and particular attention was given to the question of planting material for smallholders and the part which the Smallholders' Advisory Service should play in the schemes being prepared for replanting on smallholdings. It was accepted that budwood of proved clones is the best planting material; supplies of good clonal seed are limited and cannot be rapidly expanded; and only what is known to be the best clonal seed should be recommended for use. It was the general opinion that the greatest effort of the Smallholders' Advisory Service should be devoted to replanting work and to forwarding the replanting schemes. In these full use should be made of the Rubber Instructors' special qualifications and technical training and they should not be involved in administrative or clerical duties.

INTERIM REPLANTING SCHEME

From September onwards Rubber Instructors were directed to give all assistance required of them in the implementation of the interim replanting scheme. Demands varied in the different territories but with few exceptions the inspections of holdings and subsequent report, required for consideration of applications, occupied the greater part of Rubber Instructors' time during the last two months of the year and this had obvious effects on other branches of their work.

ADVISORY

THE DECLINE IN THE PRICE OF RUBBER has resulted in reduction in frequency of the high tapping which became common in 1951. Information is lacking to show whether the reduction in production on smallholdings is due to absence of the price incentive or to decline in yield capacity of the trees. Both may have played a part.

MANUFACTURE

As in recent years our efforts in the field of rubber processing have been directed principally to encouragement and assistance in organisation of central processing establishments. The amounts of rubber processed centrally during 1952 are given below, expressed as tons of dry rubber.

S. H. A. S. : A D V I S O R Y

	<i>Collected for sale as latex</i>	<i>Collected for sheet manufacture</i>
Selangor	601	238
Negri Sembilan	59	8
Malacca	—	80
Perak	83	86
Johore	2,046	330
Pahang	2	37
Kedah & Perlis	634	68
Penang & P. Wellesley	—	—
Kelantan	—	21
Trengganu	—	5
<i>Total</i>	<i>3,425</i>	<i>873</i>

Similar information for previous years suggests that in certain parts of the country the principle of central processing of rubber for sale as latex has become firmly established. Development in other districts may be expected as information spreads and security improves. It is emphasised that data on quantities of rubber subject to central processing are collected by Rubber Instructors, who generally have to rely on information supplied by commercial operators. This may not always be precise, but with the extension of central processing the quantities may be safely regarded as minima for the country. Figures for separate months indicate that, apart from a slight setback in the second quarter, there was a steady increase through the year in the central processing and demand for liquid latex. The high level of requirements at the end of the year may well foreshadow increased purchases of smallholders' latex. This (possibly temporary) fortunate market position should not be allowed to discourage efforts to enable the smallholder to control his own marketing more fully and to develop means for processing latex into some form of dry rubber, against a possible decline in the demand for liquid latex.

P L A N T I N G A N D R E P L A N T I N G

There has been a further small increase in the total replanting carried out on smallholdings in 1952. Only in Penang & Province Wellesley has there been a marked decline in the acreage from previous years and this may be because the greater proportion of replanting in this territory has been on areas felled during the Japanese occupation and the best of these have now been replanted. Total acreages replanted and newly planted in all territories in 1952 are given overleaf.

R. R. I. REPORT 'FIFTYTWO

	<i>Replanting</i>	<i>New planting</i>
Selangor	478	174
Negri Sembilan	372	876
Malacca	794	5
Perak	1,002	476
Johore	995	819
Pahang	95	1,458
Kedah & Perlis	339	1,799
Penang & Province Wellesley	115	—
Kelantan	60	733
Trengganu	—	385
<i>Total</i>	4,250	6,725

In the last quarter of the year the Interim Replanting Scheme stimulated considerable interest in replanting and activity in felling. There is, however, no indication that the scheme had any considerable influence on the areas planted, as in general smallholders who succeeded in planting had made preparations well in advance. The greater part of the acreage approved under the Interim Replanting Scheme will therefore have to be planted during 1953.

New planting completed during the year as shown above represents an increase of over 1,000 acres on the 1951 figure. There is no doubt as to the popularity of planting rubber on new land nor is there any difficulty in obtaining settlers whenever new land is alienated. The greatest proportion of new planting has been in the states of Pahang and Kedah, while a considerable increase is shown in the acreage for Kelantan in 1952. Continued new planting in these States will accord well with their replanting requirements which, from the age and condition of their mature rubber, are proportionately less than in such territories as Malacca, Perak, Negri Sembilan and Selangor.

PLANTING MATERIAL

The use of different types of planting material on smallholdings was dealt with in considerable detail in 1951. During 1952 there have been increases in the total planting and the planting of clonal seedlings, and a small decrease in the acreage budgrafted. If the acreage budgrafted is compared with theoretical requirements as shown by a study of the 1951 figures for planting and allowance made for the budding of about 300 acres of unrecorded new planting in Kelantan and other similar projects it will be seen that little more than half the area which should have been budded has

received attention. It should, be noted that great efforts have always been required from Rubber Instructors to initiate budgrafting on smallholdings and it is possible that the reduction which was particularly noticeable during the last three months of the year has been in part due to the heavy incidence of leave amongst Rubber Instructors and the pre-occupation of those on duty with other activities, notably the distribution of clonal seed and the supervision of smallholders clonal seedling nurseries and—an even greater burden—the inspection of holdings under the interim re-planting scheme.

Clonal seedlings have been planted up to the limit of supplies and the increase in acreage of this material may be related to the good seedfall in 1951 when $5\frac{1}{2}$ million seeds were obtained, in comparison with $4\frac{1}{2}$ million in 1950.

The use of the different types of material is shown in the table.

ESTABLISHMENT OF HIGH YIELDING AREAS IN 1952

<i>Territory</i>	<i>Total planting (acres)</i>	<i>Planted with clonal seedlings (acres)</i>	<i>Area budgrafted (acres)</i>
<i>Selangor</i>	652	510	90
<i>Negri Sembilan</i>	1,248	744	127
<i>Malacca</i>	799	421	188
<i>Perak</i>	1,478	1,144	232
<i>Johore</i>	1,814	1,089	316
<i>Pahang</i>	1,553	1,216	23
<i>Kedah & Perlis</i>	2,138	1,405	417
<i>Penang & P. Wellesley</i>	115	73	95
<i>Kelantan</i>	793	502	391
<i>Trengganu</i>	385	385	—
TOTAL	10,975	7,489	1,879

INVESTIGATIONS

THE R.R.I. SMALLHOLDING IN THE MUKIM OF AMPANG and the nursery in Ampang Road provided a certain amount of material for experimental work of the Divisions. Tapping of the pre-war re-planted areas for the Botanical Division tapping experiment continued throughout the year.

Girth measurements have been taken in the 1948 and 1949 replantings in which hedges were planted in place of every fourth row of old rubber and the balance of old rubber subjected to

heavy pruning along the new hedges. Averages of girths recorded at 60 inches are:

		<i>January</i>	<i>December</i>	<i>Increment</i>
1948	double rows 3ft x 4ft	4.4 in.	5.4 in.	1.0 in.
1948	„ „ 4ft x 4ft	5.0 in.	6.2 in.	1.2 in.
1949	„ „ 6ft x 5ft	3.7 in.	4.9 in.	1.2 in.

The measurements indicate some retardation from the old rubber and in 1953 two rows will be removed entirely from the 1948 area leaving only a single central row between hedges.

In the 1950 replanting, in which two rows of pollarded old seedling rubber trees remain between the young hedges, tapping of the pollarded trees continued but the yield declined to about 25 per cent of the 1949 yield for the area. This is mainly due to the poor bark available and to the necessity for high tapping on virgin bark. Measurements of two hedges planted with budded stumps were taken in December and averaged 4.6 inches at 60 inches from the union.

INFORMATION

ROUTINE MAINTENANCE CONTINUED on 16 replantings established as demonstrations in earlier years; fertilisers have been applied as required and special work to improve drainage was authorised on one plot. One demonstration had to be abandoned due to continued neglect by the owner, and no new demonstrations were established.

The usual course on rubber was arranged for Agricultural College students, this time at the Experiment Station itself, during six days in November. A Rubber Instructor was responsible, and 15 students attended.

A booklet 'Budgrafting', illustrated in colour by Mr Ho Choo Chuan, was issued in two editions, Malay/Chinese and English/Tamil, as S.H.A.S. Publication No. 5. A leaflet on 'Preparation and Maintenance of Clonal Seedling Nurseries' was issued in Jawi as S.H.A.S. Circular No. 2, to meet the needs of those responsible for the organisation of smallholders' nurseries.

The Department of Information distributed 16 mm copies of the six instructional films made by the Malayan Film Unit for the R.R.I. to all territories, and arranged programmes for their exhibition in the kampongs in consultation with a senior Rubber Instructor. Rubber Instructors have attended all screenings of the films. Six leaflets appropriately illustrated with 'stills' from the films were published in Romanised Malay to reinforce the lessons contained in them.

Starting in April, contributions were made to Radio Malaya for regular items on smallholders' rubber production methods for the community broadcasting programmes. These took the form of three short talks by Inche Shamsuddin, and a series of short plays — 'Haji Jaya and his kebun' — by Tuan Syed Mamdooh Wafa. This series has extended to 30 episodes and has covered a wide range of rubber smallholders problems.

L.R. DAVIDSON

Smallholders' Advisory Officer

Appendix

SUPPLY OF PLANTING MATERIAL AND PROVISION OF TECHNICAL ASSISTANCE

COLONIAL DEVELOPMENT & WELFARE SCHEME D1176

THE PART OF THE R.R.I. in this scheme has continued to be the growing of planting material — budwood and clonal seedlings — on the nurseries under the control of the Manager of the R.R.I. Experiment Station, the organisation of collection and distribution of clonal seed and the training of young men at the Experiment Station in techniques related to the establishment of high yielding rubber, to which has been added the requirements for the collection and processing of smallholders' latex in large quantities. This report therefore draws heavily on information supplied by the Manager of the R.R.I. Experiment Station.

In the different territories Rubber Instructors have assisted with allocation of available supplies and have also been responsible for collection of seed and for advice on the management of some of the nurseries under the control of the Department of Agriculture.

Budwood — The Experiment Station has maintained 67½ acres of budwood multiplication nursery throughout the year and plentiful supplies of budwood have therefore been available at all times. Distribution required has amounted to the negligible quantity of 1670 yards.

Clonal seed supplies and clonal seedling production — In accordance with a policy of decentralisation of clonal seedling production only 9 acres of clonal seedling nursery were planted during 1952. This area was planted in October at the peak of seed

production. A considerable effort was made to increase the number of sources of supply and to this end a circular setting out the objects and terms of the scheme was distributed to plantation owners by the U.P.A.M. While new offers of assistance totalled 44 the majority were unable to contribute seed for a variety of reasons. These were the smallness of the areas, unsuitable combinations of parent clones, the presence of a high proportion of rogue trees, labour difficulties aggravated by denseness of covers, and the requirements of the owners (where seed was suitable) for all available supplies. The new estates supplying seed during the year provided a very small proportion of supplies and as a result of a poor seeding season total supplies were less than in 1951 by approximately 12 per cent.

The main seeding season commenced at the beginning of August and followed the pattern recorded in 1950 and 1951 with the starting time and peak falling midway between the dates for these years. A single week at the peak, at the end of September and beginning of October, yielded more than one quarter of the total supplies and in a three week period at this season over one half of supplies were obtained. Clonal seedling stumps grown on the nursery at the Experiment Station were distributed in March, April, September, October and November according to allocations and programmes arranged in consultation with the Chief Field Officer of the Department of Agriculture. These distributions are shown in TABLE I.

TABLE I: DISTRIBUTION OF CLONAL SEED AND SEEDLING STUMPS

<i>Territory</i>	<i>Clonal seed supplied</i>	<i>Clonal seedlings stumps from Sungei Buloh</i>
<i>Selangor</i>	450,200	55,300
<i>Negri Sembilan</i>	251,850	51,000
<i>Malacca</i>	347,700	32,500
<i>Perak</i>	809,700	106,000
<i>Johore</i>	528,400	130,100
<i>Pahang</i>	786,975	90,000
<i>Kedah & Perlis</i>	706,500	95,000
<i>Penang & P. Wellesley</i>	169,600	10,000
<i>Kelantan</i>	183,900	10,000
<i>Trengganu</i>	307,100	40,000
<i>Govt Nursery</i>		
<i>R.R.I. Expt Station</i>	383,930	—
TOTAL	4,925,855	619,900

S. H. A. S.: PLANTING MATERIAL

Information collected by Rubber Instructors on the source of planting material utilised by smallholders, which may not necessarily be complete, is presented in TABLE II. The first three sources are of course dependent on the C. D. & W. Scheme for basic supplies while 'other sources' represents commercial suppliers.

TABLE II: SOURCES OF PLANTING MATERIAL USED BY SMALLHOLDERS

<i>Source</i>	<i>Budwood (yd)</i>	<i>Clonal seedling stumps</i>	<i>Clonal seed</i>
<i>Central reserve R.R.I. Expt Stn</i>	1,670	619,900	—
<i>Agricultural Station nurseries</i>	45,914	540,693	61,500
<i>Smallholders' nurseries</i>	4,093	231,470	51,250
<i>Other sources</i>	2,231	228,784	452,230
TOTAL	53,908	1,620,847	564,980

Future supplies of planting material — The seed garden at the R.R.I. Experiment Station has developed satisfactorily without encroaching on the seedling and budwood multiplication nursery areas. Reduction of the interplanted nursery area is to be expected in 1953, from the gradual spread of shade from the permanent hedges.

The area of newly alienated land at Kg. Romania in the Temerloh district selected as a future seed garden has been satisfactorily planted with seedling stumps by the smallholders. Material has been provided, in the form of budded stumps, for a small nursery on the site. The idea of developing a similar project in Trengganu has been accepted and a suitable area of new land selected at Kumpal in the district of Dungun.

Provision of technical assistance — Two courses for training young men from rural areas were held at the R.R.I. Experiment Station from January to May and from July to November. A total of 69 persons attended.

BOARD

THE CONSTITUTION OF THE BOARD IS AS PRESCRIBED by Enactment No. 14 of 1934 and the membership at 31 December 1952 was:

- a The Director of the Institute — *ex officio* — CHAIRMAN
- b The Secretary to the Treasury, Federation of Malaya
(FINANCIAL MEMBER appointed by the High Commissioner)
- c The Director of Agriculture, Federation of Malaya — *ex officio*
- d Members appointed by the High Commissioner to represent the interests of smallholders
The Hon'ble Tuan Haji Sheikh Ahmad bin Sheikh Mustapha, C.B.E., J.P., M.C.H.
Mr Fong Yeok Seng
- e Members appointed by the High Commissioner from a panel nominated by the Rubber Growers' Association, the United Planting Association of Malaya and the Malayan Estate Owners' Association
Mr A.V. Beith
The Hon'ble Mr H.H. Facer, C.B.E.
The Hon'ble Mr R.B. Carey
The Hon'ble Mr Khoo Teik Ee, C.B.E., J.P.
Mr S.J. Nias.

Members under (d) and (e) were appointed by the High Commissioner for a period of three years from 1 September 1949; therefore their term of office expired with effect from 1 September 1952. By Notification No. 2871 in the Federation of Malaya Government Gazette No. 21 Vol. V dated 21 August 1952 the above named members were appointed for a further period of three years from 1 September 1952. At the close of the year the other members of the Board were (a) Mr C.E.T. Mann (b) Mr J.E. Pepper, M.C.S. (c) Mr O.J. Voelcker, C.B.E.

The Permanent Committee consists of five members of the Board:

The Director of the Institute — *ex officio* — Chairman
The Financial Member — *ex officio*

Three members appointed by the High Commissioner

At 31 December 1952 the three appointed members were the Hon'ble Tuan Haji Sheikh Ahmad, the Hon'ble Mr Khoo Teik Ee, and Mr A.V. Beith, for three years from 1 September 1952.

During the year the Board held three statutory and two special meetings. The Permanent Committee met three times. The Housing (*ad hoc*) Committee met three times. The Estimates 1953 (*ad hoc*) Committee met once. The Conditions of Service (*ad hoc*) Committee met once.

The Rubber Research Institute of Malaya became a member of the International Rubber Research Board and the International Rubber Development Committee, with the Director as its delegate. The Director attended meetings of the I.R.R.B. and the I.R.D.C. in London in November.

In July, at the invitation of the Centrale Proefstations Vereniging, a conference of directors and research officers of rubber research institutes was held at Bogor, Indonesia. It was attended by the Director and nine research officers from the R.R.I.

At the request of the Australian Government the Board agreed that the Director should visit Papua and New Guinea to report on the condition of the rubber growing industry in those territories.

During the year the Rubber Industry (Replanting) Board was constituted by ordinance to supervise the replanting of obsolescent rubber trees in smallholdings, and to assist in this work the resources of the Smallholders' Advisory Service of the Institute have been enlisted.

Other major activities are the operation of a testing station for the technical classification of natural rubber and pilot plant investigations into the production of cyclised rubber.

The accounts for the year 1952 follow.

C.E.T. MANN

Chairman of the Board

BALANCE SHEET AS

LIABILITIES					
SUNDRY CREDITORS					
	\$	c	\$	c	\$ c
Staff			40,488.49		
Merchants			40,060.17		
Building Contractors			152,848.29		
Miscellaneous			16,834.61		
Malayan Rubber Fund (Experiment Station Account)			103,772.85		
Malayan Rubber Fund (Rubber Powder Account)			3,587.44		357,591.85
DEPOSITS					
Publications					1,538.28
RESERVE					
Leave Pay and Passages					330,000.00
EXCESS OF ASSETS OVER LIABILITIES					
Balance as at 31 December 1951			1,842,426.36		
Add Interim Payment in respect of War Damage			6,300.00		
			1,848,726.36		
Less Labourers' Quarters written off	72,535.97				
Transfer to Leave Pay and Passage Reserve	130,000.00				
Excess of Expenditure over Income	417,456.76		619,992.73		1,228,733.63
MALAYAN RUBBER FUND					
Grants for Capital Work					
Immature Rubber and Buildings			406,005.93		
Pilot Factory	365,926.00				
New Laboratories and Houses	1,261,086.00				
Rubber Powder	20,000.00		1,647,012.00		2,053,017.93

Note Further refunds of the Cess collected by The Rubber Industry (Replanting) Board on account of Cess paid in 1952 will be made but the total amount is not ascertainable at the date of the preparation of this Balance Sheet.

Carried forward

3,970,881.69

AT 31 DECEMBER 1952

ASSETS					
LAND & BUILDINGS		\$	c	\$	c
2½ Mile Compound					
Land as at 31 December 1951		15,784.35			
198 & 200 Ampang Road					
At Nominal Value		2.00		15,786.35	
3rd Mile Compound					
Land as at 31 December 1951		31,440.35			
251,253,255,257,259 & 261 Ampang Road					
At Nominal Value		6.00		31,446.35	
3¼ Mile Compound					
Land as at 31 December 1951		27,582.50			
262,264,266,268 & 270 Ampang Road					
At Nominal Value		5.00		27,587.50	
4th Mile Compound					
Land as at 31 December 1951		2,000.00			
73, 4th Mile, Ampang Road					
At Nominal Value		1.00		2,001.00	
Eaton Road Compound					
Land as at 31 December 1951		17,147.08			
1.3.5 & 7 Eaton Road					
At Nominal Value		4.00		17,151.08	
Lower Ampang Road					
Land as at 31 December 1951		43,623.50			
9 Bungalows					
As at 31 December 1951	\$379,539.60				
Additions during the year	84,031.65	463,571.25		507,194.75	
Ulu Klang					
Land as at 31 December 1951		7,705.00			
Workmen's Quarters					
As at 31 December 1951	\$ 72,536.97				
Less written off to Nominal Value	72,535.97	1.00		7,706.00	
Experiment Station					
Bungalows & Quarters					
As at 31 December 1951		546,451.15			
Additions during the year		7,069.73		553,520.88	
Laboratories					
Land as at 31 December 1951	\$ 19,526.00				
Buildings—At Nominal Value	1.00	19,527.00			
Experiment Station					
As at 31 December 1951	\$257,166.49				
Additions during the year	18,772.72	275,939.21	295,466.21	1,457,860.12	
PLANT AND MACHINERY					
As at 31 December 1951					
At Nominal Value					1.00
RUBBER POWDER PLANT & MACHINERY					
As at 31 December 1951			11,757.77		
Additions during the year			13,012.26		24,770.03
Carried forward					1,482,631.15

Brought forward

\$3,970,881.69

Carried forward

\$3,970,881.69

Brought forward		\$1,482,631.15
FURNITURE		
Residential Houses		
As at 31 December 1951		
At Nominal Value	1.00	
Experiment Station		
Laboratories	1.00	
Houses	1.00	2.00
Offices		
As at 31 December 1951		
At Nominal Value	1.00	
Library		
As at 31 December 1951		
At Nominal Value	1.00	
Laboratories		
As at 31 December 1951		
At Nominal Value	1.00	6.00
APPARATUS & GLASSWARE		
As at 31 December 1951		
At Nominal Value		1.00
MOTOR VEHICLES		
As at 31 December 1951		
At Nominal Value		1.00
WORKSHOPS		
As at 31 December 1951		
At Nominal Value		1.00
LIBRARY BOOKS & PERIODICALS		
As at 31 December 1951		
At Nominal Value		1.00
EXPERIMENT STATION DEVELOPMENT		
As at 31 December 1951	809,172.78	
Additions during the year	134,276.45	943,449.23
PILOT FACTORY		
As at 31 December 1951		422,635.66
STOCKS		
Petrol, Oil & Chemicals		
Laboratories	357.80	
Experiment Station	16,927.26	17,285.06
Empty Drums & Containers		
Laboratories	308.00	
Experiment Station	1,120.00	1,428.00
Stationery		
Laboratories		8,661.03
Sundry Materials		
Laboratories	11,514.57	
Experiment Station	11,280.48	22,795.05
Rubber		
Experiment Station	29,240.94	79,410.08
Carried forward		2,928,136.12

Brought forward

\$3,970,881.69

\$3,970,881.69

REPORT OF THE AUDITORS TO THE BOARD OF

We have examined the above Balance Sheet dated 31 December 1952 with the books all the information and explanations we have required.

In our opinion, such Balance Sheet is properly drawn up so as to exhibit a true and and the explanations given to us and as shown by the books of the Institute.

Kuala Lumpur
12 March 1953

	Brought forward		\$2,928,136.12
SUNDRY DEPOSITS			
Laboratories			170.00
SUNDRY DEBTORS			
Staff			
Loans for Motor Vehicle Purchase	201,714.25		
Travelling & Leave Advances	13,766.85	215,481.10	
General			
Laboratories	83,169.04		
Experiment Station	47,926.05	131,095.09	
Interest Accrued on Investments		2,729.97	
Payments in Advance		12,895.73	362,201.89
INVESTMENTS			
\$15,000/- 4½% Singapore Municipal Debenture Stock 1930-70/80			
As at 31 December 1951		15,000.00	
(\$17,537/- *) (\$13,949/- †)			
\$40,000/- 3% F.M.S. Govt. War Loan 1940-52/59			
As at 31 December 1951		40,000.00	
(\$40,000/- *) (\$37,600/- †)			
\$160,000/- 3% Malayan Union Govt Loan 1946-62/66			
As at 31 December 1951		160,000.00	215,000.00
(\$160,000/- *) (\$124,196/- †)			
* Original Cost			
† Market Value as at 31 December 1952			
CASH AT BANK & IN HAND			
Chartered Bank, London	877.75		
Chartered Bank, Kuala Lumpur	453,347.85		
In Hand	11,148.08	465,373.68	
			3,970,881.69

THE RUBBER RESEARCH INSTITUTE OF MALAYA

and vouchers of the Rubber Research Institute of Malaya and report that we have obtained correct view of the state of the Institute's affairs according to the best of our information

Sgd Peat, Marwick, Mitchell & Co.
Chartered Accountants
Auditors

Income & Expenditure Account (excluding Experiment)

EXPENDITURE		\$ c
To		
Board & Committee (Fee & Expenses)		2,577.00
London Advisory Committee: Contribution for Research		109,243.52
Salaries & Allowances		1,115,386.21
Gratuities		11,905.67
Provident Fund Contributions		107,589.60
Leave Pay & Passages		145,406.43
Medical		15,294.52
Recruiting		14,513.68
Travelling		56,170.39
Printing, Stationery, Postage, Telephone, Audit & Legal		37,670.99
Rents, Rates & Taxes		10,196.70
Insurance		29,512.15
Maintenance of Laboratories & Houses		40,215.68
Maintenance of Grounds		10,667.49
Furniture & Office Equipment		115,784.81
Fixtures & Fittings		5,899.53
Power, Light, Water & Sanitation		40,790.53
Plant & Machinery: Repairs & Running (excluding Power)		19,403.14
Workshop		5,513.21
Apparatus & Glassware		95,215.49
Motor Vehicles Running & Replacements less Sales		20,642.45
Chemicals		17,244.96
Publications		15,668.69
Library: New Books, Periodicals & Sundries		12,196.22
Exhibitions & Conferences		4,766.14
Smallholders' Advisory Service		516,890.55
Experiments: Field & Testing Laboratories		137,816.92
Technical Classification of Rubber		29,894.63
		2,744,077.30

Income & Expenditure Account for Experiment

EXPENDITURE		\$ c
To		
Revenue Expenditure		586,894.51
Excess of Income over Expenditure to be refunded to the Malayan Rubber Fund		103,772.85
		690,667.36

Station) for year ended 31 December 1952

INCOME			
		\$	c
By			
Authorised Contribution for 1952 from Malayan Rubber Fund	2,307,082.00		
Less Over-payment in 1951 on account of other territories adjusted in 1952	13,768.80	2,293,313.20	
Publications Sold		3,012.20	
Rents on Houses		5,979.14	
Interest on Loans		2,693.17	
Interest on Investments		10,646.95	
Miscellaneous		10,975.88	
Balance being Excess of Expenditure over Income		417,456.76	

2,744,077.30

Station for year ended 31 December 1952

INCOME			
		\$	c
By			
Sales and Stock of Rubber	666,725.32		
Sales of Planting Materials	12,893.17		
Rubber Industry (Replanting) Board Refund on account of Replanting Cess	11,048.87	690,667.36	

